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LIVE AND LET LIVE.

A FORTNIGHT ago we made a brief reference to the increasing promise of the electrical outlook, and prognosticated that those firms which are in a position to do profitable work will in the coming days find plenty of work to do. We reiterate our belief that a revival of electric lighting is in progress; there are signs of activity in the electrical world which can only lead to the comforting assurance that the forthcoming winter will witness the majority of electrical people busily engaged in carrying out remunerative contracts. It is a sad fact to reflect upon, that the number of firms capable of conducting extensive work in this direction is so small compared with the multitudinous array of fearfully and wonderfully-named electrical corporations which one was familiar with a few years ago; sad, because one regrets the large amount of good money literally wasted. But the prospect is all the better for the few that remain: they have a practically limitless field before them, and we shall expect them to make satisfactory use of their opportunities by covering the country with installations which shall redound to their credit, and place the certainty and safety of electric lighting beyond all shadow of doubt.

It is difficult to say to what extent electric lighting has already been adopted in this country. Some kind statistician would place us under a lasting obligation if he would but ascertain the facts and figures for us; because, for our part, we find it no easy task to obtain reliable information from interested parties. To give one kind of illustration of what we mean, one well-known firm but a short time ago courteously but distinctly refused to disclose the names of places where it was fitting up installations. This reticence leaves behind it an erroneous impression of the amount of work going forward in the country; but, of course, there is a reason for it, and a reason which is not far to seek. From what we can gather, no sooner does it become known that a certain firm is negotiating with the constituted authorities of a country town for the purpose of introducing the electric light into that town, than down swoop other would-be contractors upon the bewildered community, with arts and wiles and accomplished cajolery, with the determined intention to oust, *coute que coute*, the first comer. Sometimes the temptation assumes the form of a great reduction in the matter of cost; and not infrequently it goes even so far as the offer to do the lighting for a specified period gratuitously. In the face of the repeated assurances of respective and respectable chairmen of companies that "*We* don't do that sort of thing," the frequency with which these cutting-out tactics are resorted to, as well as the frequency of their success, is somewhat surprising, for the inference is plain that somebody must be saying the thing which is not.

A glaring instance of the procedure which has aroused our indignation has recently been brought before our notice with respect to a fashionable seaside resort. In this case publicity had been given to certain passages between the local authorities and those who were preparing to establish the electric light, and everything was regarded by those directly concerned as satisfactorily arranged; indeed, so far had matters progressed, that a local syndicate had been formed with a presumably well-known local resident as chairman. When this became known a gentleman officially connected with an electric light company not entirely unknown to fame hurried to the scene of action, and, in brief, "he came, he saw, he conquered." Whether an offer was made to supply gratuitously the plant for which the syndicate would otherwise have to pay, or by what means the *coup* was accomplished, we cannot precisely say; but the fact remains that the chairman of the syndicate fell a victim to the persuasive powers of the new comer, and the original promoters of the scheme had, for the time being, at all events, to go empty away

Another instance we have heard of, where the lighting of a mill was as good as assured to one firm, when another came upon the scene with an offer to do the work upon such reduced terms that the owner could not resist the inducement. The "job" was done, and all went merrily as marriage bells for awhile; but trouble loomed in the not far distant future. Suddenly the leads went wrong, and, to cut the story short, the last we heard of the installation was that it had been three times re-wired. The moral of this narrative is obvious.

Is this kind of competition (if competition it can be called) fair? To our minds such proceedings are detrimental to the interests of the whole industry, and result in benefit neither to the firm supplanted nor to the supplanter. The former finds itself, after spending perhaps a month or six weeks in the effort to show the representatives of the townspeople, where town lighting is the object sought after, the advantages of the electric light, a heavy loser by what, to put matters as mildly as possible, we must call the underhanded action of a till then unthought of opponent. To the latter such a success is of doubtful advantage, for the time occupied in wresting from the grasp of another an installation which at best is, at the beginning, only experimental, might have been better employed in searching for *bonâ fide* orders of a permanent nature. It is high time in the interests of the electrical industry that these methods of procedure were abandoned, and that a higher standard of commercial morality should obtain. People who are negotiating for the carrying out of electrical work should, if competent to perform their contracts, be allowed to complete their plans without molestation.

Notwithstanding the fact that we have reason to be satisfied with the progress which has been so far made electrically in this country in the face of so many obstacles, it is yet undesirable in the interests of the community that the public should be kept in the dark

as to the real amount of work going on, because contractors dread the interference of rival firms which might result if their movements obtained publicity. We counsel those to whom our remarks have particular reference for their own sakes to abandon their vulture-like habits and to leave the rewards of industry to those who have laboured for them.

THE GREAT BRUSH DYNAMO.

DR. ROBT. H. THURSTON, director of Sibley College, Cornell University, gave at the Buffalo meeting of the American Association for the Advancement of Science, August 19th, 1886, a description of the great dynamo-electric machine built by the Brush Electric Company for the Cowles Electric Smelting and Aluminum Company, with an account of trial tests made of the machine. The paper was afterwards revised for publication in the journal of the Franklin Institute, and reads as follows :—

The process of reduction of aluminum and other metals, and production of alloys, invented by Messrs. Eugene H. and Alfred H. Cowles, and perfected with the assistance of Professor Mabery, of Cleveland, O., has attracted the attention of engineers, as well as of men of science, not only on account of the ingenuity, simplicity, and effectiveness of the process itself, but also, and probably quite as much, because of its bringing into use the voltaic arc and dynamo-electric machines of exceptional and enormous power.

The writer, on the occasion of a recent trip to the West, was, on his return journey, so fortunate as to be able to stop in Cleveland long enough to witness the operation of the process, and to be present at the first trial of the great dynamo recently completed by the Brush Electric Company for the Cowles Electric Smelting and Aluminum Company. The occasion was so interesting, and the facts developed so striking and probably important, that it has been thought worth while to present a very brief account of them to the members of this section of the American Association for Advancement of Science.

The Cowles process, as will be remembered by those who listened to the interesting account given the association at the Ann Arbor meeting of 1885, and published in the *American Journal of Science* for October of that year, or who have read the interesting paper of Mr. Eugene H. Cowles, read at the stated meeting of the Franklin Institute, in January, 1886, and published in the Journal for February, 1886, consists in the passage of a powerful current of electricity from a "dynamo" through a mass of ore mixed with carbon and other material forming the "charge," until the action of the heat, and possibly of the electrical force, causes a reduction of the ores and the formation of an alloy of the metals so reduced. The apparatus consists simply of a powerful dynamo-electrical machine, connected with a pair of carbon electrodes of correspondingly exceptional size, these electrodes being enclosed in a furnace of brickwork, lined with the most refractory available material. The Cowles Company have several dynamos, all of large size, but it is the intention of the writer to describe but one, the latest built and the largest. The next smaller, which was until recently considered a very powerful machine, weighs about two tons and a-half, is driven at 900 revolutions per minute, and produces a current of 1,575 ampères, with an E.M.F. of forty-five volts. These machines are "shunt-wound" and very nicely proportioned under the direction of the inventor, Mr. Charles F. Brush, whose interest in the work induced him to give to this construction his personal attention. The largest machine, recently completed, and under test at the time of the visit of the writer to the works, weighs 21,900 lbs. (9,934 kgs.), a so-called 42-inch (1060·6 mm.) machine, the armature having that diameter. The armature contains 1,600 lbs. (725·7 kgs.) of iron ; it carries 825 lbs. (378 kgs.) of copper wire, while the field-magnets are wound with about six times that weight, 5,424 lbs. (2641·8 kgs.).

The armature of this great dynamo consists of sixteen bobbins, each carrying twenty-one turns of best copper wire, two strands lying side by side, the wire being 0·35 inch in diameter (8·89 mm.). These sixteen bobbins are operated in multiple arc, thus giving thirty-two strands of copper wire of the diameter above stated, and about 65 ft. (19·8 m.) long. Sixteen copper bars carry the current from the bobbins to the commutator, each bar being one inch by one-half inch (25·4 mm. by 12·7 mm.) in section. The two commutators are coupled in multiple arc.

The field magnets are eight in number, and consist of a cylindrical cast iron core, 11 inches (279·4 mm.) in diameter, by 16 inches (406·4 mm.) in length, and wound with thirty layers of 102 turns, each of copper wire, 0·134 inch (3·404 mm.) in diameter ; all the eight wires are coupled in multiple arc as in a shunt-field. Thus combined they have a resistance of about one ohm, total, cold. The pole pieces are of peculiar form, and fitted carefully to the field.

The driving shaft, carrying the armature, is 13 ft. (3.962 m.) long, and 5½ in. (139·7 mm.) in diameter in the main bearing ; it is made of open hearth steel, furnished by the Otis Company. The machine is driven by means of a 44-inch (1117·6 mm.) double belt, turning a 40-inch (1,016 mm.) pulley on the armature shaft. The machine occupies a space on the floor about 15 ft. (4·572 mm.) long, and 4 ft. (1·219 m.) wide, and stands about 5 ft. (1·52 m.) high.

This dynamo was calculated to furnish a current of 3,200 ampères, with an electromotive force of eighty volts, with a normal maximum current in the field of eighty ampéres ; the speed of rotation not to exceed 600 revolutions per minute. Its actual speed was a little above 400 when doing the full amount of work demanded. The maximum field is thus obtained with but about 2 and 1½ per cent. of the normal current (3,200 ampères), and falling to 1 per cent. when less E.M.F. is needed. When in operation, the writer found no observable heating in any part of the machine, and the bearings ran perfectly free from heating or cutting. The efficiency of the machine must be very great, as, after its longest run of two hours, the armature was cool enough to handle with perfect comfort. The writer could bear his hand on every accessible part of the machine, which included all parts liable to any serious heating. The belt was new and stiff, and occasionally slipped as the limit of the power of the machine was approached ; but that was a fault which a little work would cure, by making the belt flexible and giving it a better bearing on its pulleys. Had the engine driving it been of sufficient power, it was evident much more work could have been done than was actually performed on the trial. It was judged that it might have been driven up to 300,000 watts with safety. The conductors provided, and the resistance coil used in measuring the power developed, were, however, about at the limit of their endurance. As it was, the former heating until they were blue, and the latter requiring constant watching and cooling by application of water, the maximum reached was 249,000 watts, or 334 electrical horse-power, the engine probably developing not far from 400 indicated horse-power. No indicators had been fitted, and it was impossible to measure this factor. The limit of its power was reached, however, and the power of the dynamo could not be tested to its maximum. The speed intended was, for the dynamo, 430 revolutions, but at 80 volts it could not be driven by the engine up to that speed.

The dynamo was built, complete, in all its details, from the specifications of Mr. Brush, and without preliminary experiment, and, when tested, was found to require no alterations of any kind, and came fully up to the requirements of the specifications and contract. Its capacity is very much greater than that of any machine yet built in the United States, or in the world

Its successful construction is considered by its designer to indicate that it is possible to design a machine of any desired size and power, with perfect confidence that it will come fully up to the calculated performance. No limit is to be seen, as yet, to the size and power of the machines, if properly designed. Their construction is a matter of definite calculation, and is to-day independent of direct experiment. The fact that a dynamo may be precisely designed and proportioned for any kind and amount of work that may be demanded, for any purpose whatever, without limit, so far as can be to-day perceived, is one of the most interesting and important revelations of recent work in this field. The fact, also plainly shown by the experience of the Cowles Company, in the use of these enormous machines, that the larger the machine, the higher the duty of the plant, is no less interesting and important. The economy secured in the production of their aluminum and other alloys, by the increased size of the later dynamos put in operation, is so great as to be a very valuable factor in the operation of the business, each new and larger machine very considerably reducing the price at which the metals can be put on the market.

EXPERIMENTS WITH 42-INCH BRUSH MACHINE.
JUNE 25th, 1886.

Revolutions per Minute.	E.M.F. Volts in External Circuit.	Ampères in External Circuit.	Ampères in Field Shunt.	Watts in External Circuit.
428	78	1,000	33½	78,000
424	68	2,000	30½	136,000
423	56	2,500	27½	140,000
420	66	2,600	37½	171,600
418	72	2,640	46½	190,080
410	76	2,700	58	205,200
420	94	2,040	89	191,760
412	88	2,450	85	215,600
410	86	2,700	83	232,200
410	85	2,800	82	238,000
405	83	3,200	80	249,000
423	56	2,700	29	151,200
423	54	3,150	35	170,100
423	62	3,400	45	210,800
423	66	3,400	50	224,400
423	68	3,400	52	231,200
423	52	3,000	33	156,000
421	46	2,950	28	135,700
421	36	2,620	21½	94,320
421	32	2,500	19	80,000
421	26	2,300	16	59,800
421	22	2,100	15	46,200
421	19	I,850	13	35,150
431	100	0,000	76	
431	105	0,000	100	

The tabulated statement shown herewith presents the figures obtained at the trial of the ten-ton dynamo above described, and will repay careful study, as they exhibit the effect of variation of speed, of variation of current in the field shunt, and of electromotive force, in the production of energy in the external circuit. The highest power attained on this occasion was, as shown in line 11 of the table, 249,000 watts, the speed of revolution being 405 (25 turns below the regular speed), the electromotive force being 83 volts (three above the standard), and the current measuring 3,200 ampères. The electromotive force in the shunt coils was 80 volts. The heaviest current measured 3,400 ampères, the electromotive force being 68 in the main current and 52 in the shunt, the current energy measuring 231,000 watts at the terminals. At the standard speed of rotation, the circuit being broken, the measured electromotive force was 100 volts.

This remarkable and powerful machine was driven, at the time of the visit of the writer to the works, by a Corliss engine through a heavy countershaft, the engine belt being carried over the belt from the jack-shaft pulley to the machine. This arrangement is an unusual, but perfectly practicable one, and, in this case, worked admirably. It was occasionally necessary to readjust the position of the dynamo, as the belt, which was new and stiff and smooth, stretched more on one side than on the other; but this stretching will soon cease, probably has ceased, and, as the belt becomes more flexible, and more perfectly fitted to its pulleys, and as it takes its maximum stretch, it is evident that it will work with perfect accuracy and will be competent to transmit any load that the dynamo can be expected to throw upon it.

The current from the machine to the furnace was conveyed by ropes of fine copper wire, or by conductors made up of several heavy wires. At the furnace, they were connected to the terminals, which latter were of bar copper, apparently about 2¼ inches in diameter, armed with four carbons each, the latter of about the same diameter and 4 feet long. Between these was arranged the conducting material which furnished the incandescent bed in which the operation of reduction was carried on. This process is not, as is very often assumed, by professionals as well as non-professionals, an application of the voltaic arc to the production of high temperatures. Such an application was made by Sir William Siemens and by other experimenters from the time of the discovery of the intense heat of the arc; but it is, in the Cowles process, an application of the incandescence, as distinguished from the arc, system. A connection is established between the carbon terminals, by means of a mass of carbon and other material, which mass is carefully kept continuous and incandescent throughout the whole operation. This is essential both to the success, actual and economical, of the process, and as distinguishing it from the older and wasteful systems of melting. By this system, the intense, the immeasurable heat of the arc is tempered and diffused throughout a large volume of incandescent material, and becomes adjustable and capable of regulation with comparative ease and exactness. Such control is thus secured as to make it convenient and economical in application to the reduction of ores and the melting of alloys and metals. Actual contact carries, everywhere, probably a very large proportion of the current, and the heat is distributed among numberless little particles of highly heated carbon, which lend each its share to the numberless particles of the compounds to be reduced.

It is probably only by some such application of the electric heat that corundum can be made to surrender its aluminum to form an alloy with copper. It has been stated recently, in the discussion of this process, as described by Dr. Mehner, before the Association for the Advancement of Science in the kingdom of Prussia, at the Berlin meeting of the present year, that this reduction had been accomplished in a furnace heated in the ordinary manner; but it would seem that this must be a mistake, since alumina is one of the most refractory substances known in nature; it is said to be even more so than the materials of our furnaces and of our crucibles. The Messrs. Cowles have subjected it to the highest temperatures that a Dixon crucible would bear, without being able to reduce it or to melt it, in the presence of carbon and copper. Further, it would be probably impossible to successfully maintain a reducing flame, if that were attempted, or to avoid the reoxidisation of the metal were its reduction primarily possible. The reducing temperature of the compound is above the temperature of volatilization, also, of the pure metal, and this would make it improbable that its reduction in this way should be successfully performed, far less with commercial success. The volatilized metal would rapidly escape from the Siemens furnace or from any other familiar form of furnace, while no other process than that above described would be capable of forming the volatilized metal in a closed furnace. In the Cowles furnace it is practicable to reduce alumina either with or without the presence of copper or other alloying metal, and one of the first intimations of the production of the working temperatures in that furnace is the appearance of fumes, indicating some volatilization to be produced. As ordinarily conducted, this is not an important amount. Alloys of aluminum have been made in this furnace with nearly all familiar metals, a proof that copper, at least, is not essential to secure the reduction. So far

as the writer has been informed, this is the only process by which reduction of this metal with carbon alone can be accomplished. The production of the metal commercially, in this manner, is expected to soon become an accomplished fact. The manufacture of the aluminum alloys has now for some time been successfully carried on, the cost of the aluminum in the alloy having been reduced to a small fraction of the price for which the metal is sold as made by the older method. The Messrs. Cowles and Professor Mabery have opened a new and broad field of experiment, and no one can surmise even what may come of the infinite range of possibilities so presented.

THE COMPOSITION OF CERTAIN PRODUCTS FROM THE COWLES ELECTRICAL FURNACE.*

By Prof. C. F. MABERY.

AT the meeting of this association last year at Ann Arbor, a paper was presented by the Messrs. Cowles and myself, which gave a description of the electrical furnace and of the products which had then been obtained from it. During the past year, several improvements have been introduced into the construction of the furnace which have increased its efficiency very considerably; and, although, as compared with results that will probably be reached in the application of electricity to smelting purposes, the present development of the process may in the future seem very crude, it has already reached the stage when by actual trials, extending over considerable periods of time, its commercial success can be satisfactorily demonstrated. Those who listened to that paper, or who read it subsequently, will remember that the principle of the furnace is based upon the intense heat that may be produced by the resistance which is encountered when a powerful electric current is passed between electrodes through coarsely pulverised charcoal. In late experiments, it was found by A. H. Cowles that the efficiency of the charcoal could be largely increased, and the rather rapid formation of graphite prevented, to a certain extent, if the charcoal were coated with lime previous to using it. It was also found that the quantity of product formed was increased when the electrodes were allowed to enter the mixture of ore and carbon in an inclined position, at an angle of about 30° from the horizontal plane. A continuous reduction is more easily effected when the electrodes are capable of being drawn apart so as to gradually expose fresh portions of ore to the action of the current. But perhaps the most important modification for the economy of the process is the adaptation of the furnace by the Messrs. Cowles for the reception of very powerful currents. It consists of a general enlargement of the furnace and the accessory apparatus, including electrodes, conductors, and resistance boxes, with certain variations in the detail of its construction. Now the energy from 300 horse-power may be utilised instead of that from 30 horse-power, which was formerly employed. Inasmuch as the resources of the company have been fully occupied during the past year in the development of the commercial features of the process, it may seem that the scientific possibilities have not received due attention. While this criticism may be true in part, I think I shall be able to show that incidentally considerable material of some interest from a scientific standpoint has been collected. I have recently noticed certain statements of opinion concerning the furnace and the process that are not strictly accurate.

In the discussion that followed a paper read by Dr. Mehner, of Berlin, Dr. Martius was inclined to the belief that the metal aluminum was of no greater value for ornamental purposes than zinc, and that its alloys possessed no properties relating to corrosion, strength, &c., that were worthy of mention. These assertions can best be answered by referring to the actual properties of these metals which are established beyond doubt. But the opinion expressed by Dr. Werner Siemens, that so far as practical results are concerned, this electrical furnace is identical with that constructed by his brother, Sir William Siemens, is of more importance. The continuous working of an electrical furnace requires as nearly as possible a constant resistance between the electrodes. Assuming that a dynamo machine was carrying the energy from 300 horse-power and distributing it in an arc a few inches in length, and that suddenly the arc was broken by the introduction of fresh material, the effect upon the dynamo can be imagined. Dr. Siemens thought that the reduction of aluminum depended upon the presence of copper, and he expressed doubts as to whether reduction would result in its absence. Reference was made to the statement that aluminum bronze had been made in a crucible furnace by fusing together copper carbon and corundum. We have tried the latter experiment at the highest temperature we could produce in a crucible furnace without the slightest reduction of aluminum. Nevertheless, it may be true that traces of aluminum can be introduced into copper by this method. The assertion of Dr. Siemens that aluminum could not be reduced without copper is erroneous. We have repeatedly taken mixtures of metallic aluminum and carbon from the furnace in large quantities. The question by another chemist as to whether any analysis of the products had been made followed a remark by Dr. Martius that they did not need to be informed by Americans concerning aluminum or its alloys.

A product which has attracted considerable attention during the past year is obtained by reducing aluminum in presence of iron. A cast iron is formed containing sometimes as much as ten per cent. of aluminum, and this product is used to facilitate the working of crude iron and to introduce into the various grades a small percentage of aluminium. The slags resulting from this reduction are composed chiefly of calcic aluminate and cast iron. In the reduction of aluminum in the presence of copper, a yellow product is frequently taken from the furnace, which is composed of metallic aluminum to the extent of one-half or three-fourths, the balance being silicon and copper. With a small percentage of calcium it is also formed in the absence of copper and then contains a higher percentage of aluminum and often contains nitrogen. It has a resinous lustre and decomposes water at 100° C. The aluminum slags are composed of reduced metal, calcic aluminate and fused oxide, and since they have always proved to contain about one per cent. of carbon, which is liberated in the gaseous form by hydrochloric acid even in the absence of iron, a carbide of aluminum may also be present. A remarkable effect was observed in a bar of ten per cent. bronze which had been heated for the purpose of forging, It was allowed to become too hot and when struck the entire bar assumed a crystalline condition. Some of the individual crystals were nearly perfect in form, resembling certain forms of the isometric system. A striking analogy between them and certain forms of meteorites, has recently been observed by Mr. O. W. Huntington, of Howard College. In the reduction of silicon, the formation of a greenish-yellow substance is frequently observed, and it has proved by analysis to be a new oxide of silicon—Si O. By fusion with fluxes it is converted into the dioxide, and hydrofluoric acid acts upon it the same as upon the dioxide.

The ingot of metallic aluminum here shown contains less silicon and iron than the average commercial metal, although no special care was taken to obtain a pure product. It was made by methods which are controlled by patents held by the company, and experiments are in progress which it is expected will lead to results that will cheapen very materially the cost of its production.

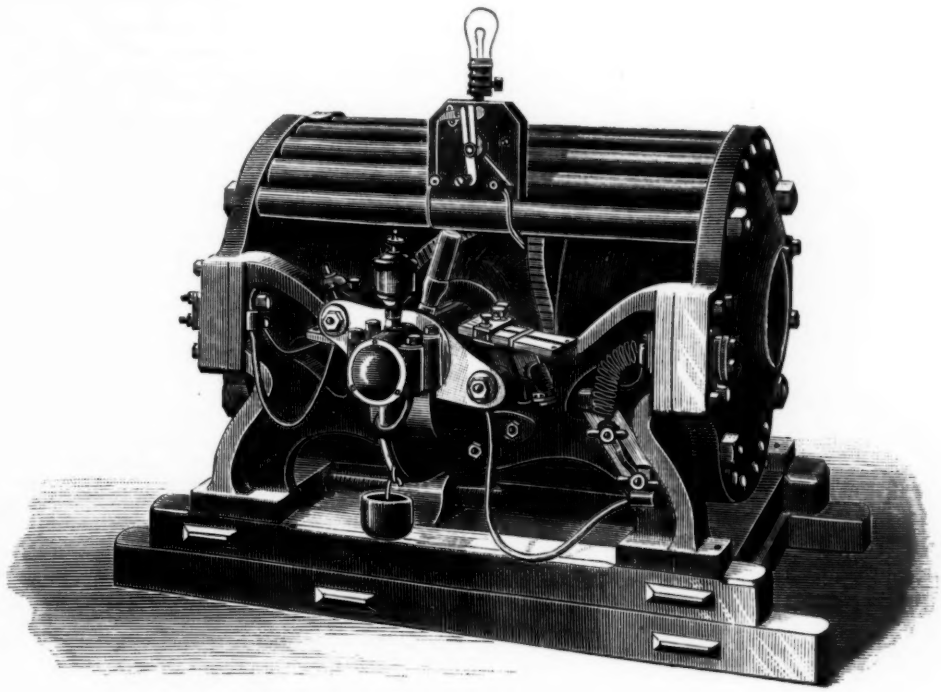
* Read at the Buffalo Meeting of the American Association for the Advancement of Science, August, 1886, and revised for publication in the Franklin Institute Journal by the author.

THE THOMSON INCANDESCENT DYNAMO.

THE Thomson-Houston Electric Company was among the first to introduce the system of placing incandescent lamps on arc circuits, the *Electrical World* states, but in order to meet the increasing demand for incandescent lights, Prof. Elihu Thomson has designed a dynamo to be used exclusively for multiple arc or incandescent working.

In the new machine, the design of the field magnets is similar to that in the arc machines; but while the spherical type of armature is retained, the three-coil winding of the arc machine is replaced by a winding similar to that of Siemens, with a commutator consisting of numerous segments, as usual in such machines.

The mode of winding the armature and making the connections to the commutator bars is, however, peculiar to the machine. The leading wires from the commutator bars are carried along the shaft into the body of the armature and outwards to its periphery, the joints to the armature convolutions being made on the outside



of the armature near its centre line, or greatest periphery.

The armature core is constructed of rings of annealed sheet-iron piled together and carried by hubs on the shaft. The field-magnets, although similar in disposition to those in the Thomson-Houston Company's arc light machines, are more solid and massive. The cores of the field magnets are wound only with wire which is placed in shunt, or derived circuit to the external circuit, but it will also be noticed that there are two coarse wire coils situated between the field magnets, and directly over and around the armature, which coils also occupy an inclined position backward to the direction in which the armature rotates. The effect of these coarse wire coils is a double one. In the first place, since they are traversed by the main current of the machine, which varies with the number of lamps in use, or the load, they compound the machine or cause, by a direct magnetising action on the armature, the potential of the machine to remain constant under varying loads. Again, by an adjustment originally made, the potential may increase to a determined percentage under full load. The second effect, or function, of the coarse wire coils is due to their inclined position, their plane of position not coinciding with a plane at right angles to the axis of the field magnets, but being displaced backward to the direction of revolution of the armature. It is well known that during the operation of a dynamo there is a distortion of the field magnetism due to the reaction of the currents in the armature upon the magnetism produced by the field magnets, and that the distortion is forward in the direction of revolution, necessitating the adjustment of the brushes on the commutator forward, when the current in the armature, or load, is increased. With the inclined coils in the Thomson-Houston machine, there is produced a counter distortion in direct proportion to the load, which neutralises the distortion due to the armature currents, and results in the production of a machine whose brushes do not need adjustment during changes of loads. The compounding of the machine by a magnetic action directly exerted on the revolving armature core by the main circuit, gives rise to a new class of compound-wound dynamos, and the utilisation of the same means to counteract the distortion and lead is certainly a new departure of considerable interest.

The machines are built either for maintaining a constant potential on the mains, or for giving a definite increase of potential, as the load is put on, so as to compensate for the fall occasioned by the resistance of the mains. Machines giving 75, 110, and 150 volts as standards have been constructed of this type with eminent success.

These machines have already been put in operation in various places, and have shown themselves capable of taking care of the load without any external regulation whatever. This, evidently, is a great advantage, and reduces to a minimum the liability to trouble.

The Proposed Bradford Time Ball.—At a meeting of the Bradford Chamber of Commerce, held last week, a letter was read from the Secretary to the Post Office, stating that the department could only undertake to supply a time ball to Bradford on condition that a rental on the usual terms be paid. A committee was appointed to wait upon the Town Council on the subject, and to urge the necessity for the early provision of a reliable time current, the town having nothing of the kind at present.

THE ELECTRIC LOCOMOTIVE AND POWER COMPANY.

IN our issue of December 5th last we fully described and illustrated Mr. Elieson's electric engine, as constructed by this company for tramway purposes. Since that date several others have been built, with the view of working the North Metropolitan Tramway Company's line from Stratford Church to Manor Park, a length of 2½ miles. These are now in course of completion at the Stratford depôt of the Tramway Company, and are being run and tested as opportunities can be found. On Thursday afternoon last week, one of these locomotives, with an ordinary passenger car attached, made an experimental journey over the line with results in every way successful and encouraging. The start was made about three o'clock, and the 2½ miles run was accomplished in a little over 17 minutes. The road was very wet, and was considerably blocked by farm carts with their occupants snug under hoods or tarpaulins, either asleep or stone deaf, no amount of whistling being sufficient to persuade them to clear the track. In this way numerous illustrations were afforded of the ease with which the speed could be slackened, or a sudden stop made, and on one occasion, when half way up a bridge having an incline of 1 in 27, the cars were brought to a dead stand with the utmost facility.

The motor is placed beneath the floor of the locomotive, and the accumulators, 80 in number, are piled against the sides, leaving a clear passage from front to back, except that in the middle there is a lever for reversing the motor. The storage cells are specially constructed with a view to efficiency and durability, and though heavy, comparatively, are well adapted to stand jolting and hard usage. Each lead plate, which is about 9 inches square, has about 150 divisions, in every one of which is a coil of lead ribbon rolled up with asbestos paper, the result being a large amount of surface exposure. Each pair of plates gives 25 ampère-hours, and the cells are made up of 13 plates. The total weight of the 80 cells is about 66 cwt., and the gross weight of the locomotive 6 tons 17 cwt. The accumulators are calculated to run the car for about six hours without renewal, which is, of course, much longer than there is any practical necessity for. A trial has proved that this locomotive is capable of moving a load of 28 tons. During the run on Thursday the current varied from 75 ampères at starting to about 25 when working up-hill, with an electromotive force of about 160 volts. The progress of the company has been seriously retarded by delay in obtaining the necessary Parliamentary powers, the late dissolution and election having postponed the legislative sanction of the regular running of electric trams in London till next year, but a full service of cars is in readiness to commence operations immediately this is arranged.

THE ELECTRICAL TRAMWAYS AT BRUSSELS.

UP to the present the tramways worked by accumulators have been confined to the domain of experiment, and our readers, says *La Nature*, have certainly not forgotten the trials made in 1882 and 1883 by M. Philippart; but, thanks to the improvements made in accumulators and electric motors, and to a deeper study of the thousand and one details involved in the problem, the system has passed out of the region of experiment into that of practice: at Hamburg two electrical carriages designed by Julien are in use; a regular service is in process of organisation at Brussels, and will be at work in a few months.

Each car carries its own accumulators and the motor worked by them. The accumulators placed under the seats of the carriage are 96 in number, consisting of eight distinct boxes, each containing 12 accumulators. Each accumulator weighs about 10 kilogrammes when empty, and contains 17 plates; its capacity is 150 ampére hours, or 15 ampére hours per kilogramme of plates. The total weight of the eight boxes full of liquid is 1,100 kilogrammes.

This number of 96 accumulators is excessive for the service of the tramway to the exhibition of the *Palais de l'Industrie*. It is calculated to ascend inclines of four centimetres per metre; at Brussels, where these cars are to be used, with these 96 accumulators, the speed on the level easily attains to 25 kilometres per hour. The tramcar itself, when in working order, but without passengers, weighs 5,370 kilogrammes. It holds 38 passengers, 16 inside, and 11 on each of the platforms, but we pity these passengers when the tram is full, for the platforms seem excessively small.

The interesting features of the system consist in the mode of construction, the charging and management of the accumulators.

M. Julien's accumulators are of the Faure-Sellon-Volckmar type, but they differ from them in the nature of the plates which are formed of a special alloy of lead and antimony which renders them impervious to the action of the current, and greatly increases their solidity and prolongs their duration. The jury at the Antwerp Exhibition* assigned them a limit below six months for regular daily work, but the experiments made by the company show that this limit may be considerably exceeded. For the charge, each box of 12 accumulators in series is placed on a charging bench (fig. 2), and the communications suitable for the charge are made automatically from underneath, by the aid of metallic spring soles let in under the box and connected electrically with the two poles of the battery of accumulators. These soles are arranged to come under similar ones in the bench connected with the charging dynamo. Finally, similar soles are made in the interior of the tramcar, and establish automatically the necessary communications, by the mere fact that the box of 12 accumulators slides from the charging bench into the carriage.

There are always two series of accumulators employed; one charged upon the bench, the other in use in the car, the substitution is effected very simply; when one series is exhausted, the car is brought to the empty charging bench, the accumulators are withdrawn after the sides have been drawn out, the car is then brought to the second charging bench, and the recharged accumulators are slipped into the place of the others. This manœuvre only occupies a few minutes, and is effected without a single wire having to be attached or withdrawn. The boxes being quite uniform may be interchanged at will. The charging on the benches presents no point particularly worthy of mention; it is generally effected in two groups of 48 accumulators in series each, with a shunt wound dynamo giving from 100 to 110 volts; the charge is calculated to be completed in about the same time as the discharge in order to lose no time.

The coupling of the accumulators on the carriage during the service presents also a certain amount of interest. The eight boxes are first connected two and two in series in an invariable manner, thus forming four distinct groups of 24 accumulators each. The two free extremities of each group and the terminals of the motor are connected with 10 wires, the ends of which, at the two extremities of the carriage, communicate with a revolving commutator which effects the following groupings.

Position of rest. All the circuits open.

First Notch.—The four groups in derivation on the motor.

Second Notch.—The four groups arranged, two in series and two in derivation on the motor.

Third Notch.—Three groups in series on the motor. The fourth group in derivation on one of the three first.

Fourth Notch.—The four groups in series.

Fifth Notch.—Of equalisation. The four groups are connected together in derivation to equalise the charges,

* See report in ELECTRICAL REVIEW for January 22nd and 29th, 1886.

but do not communicate with the motor. This is the normal position during the intervals of the stoppages.

A handle with vertical axis enables all these positions to be taken successively at will very rapidly according to the speed required, and the exigencies of the route, inclines, curves, &c. The first notch corresponds to the starting, the fourth to the running at full speed on a level straight road. The other notches correspond to intermediate speeds and requirements. The passage from one notch to the other is only effected after the lever working two pairs of brushes, the one for proceeding in one direction, and the other for proceeding in the opposite one.

The lighting is effected by means of two incandescence lamps of from 45 to 48 volts, fed by a group of 48 accumulators in series, which thus remain independent of the different couplings of the accumulators.

The commutator with variable couplings is arranged double ; there is one at each extremity of the car, but it can only be put into action by a single handle which

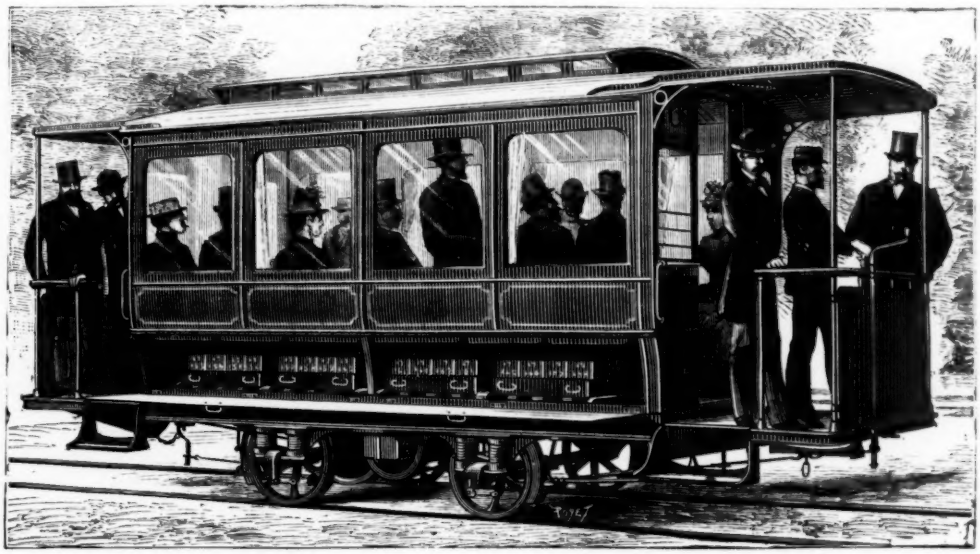


FIG. 1.

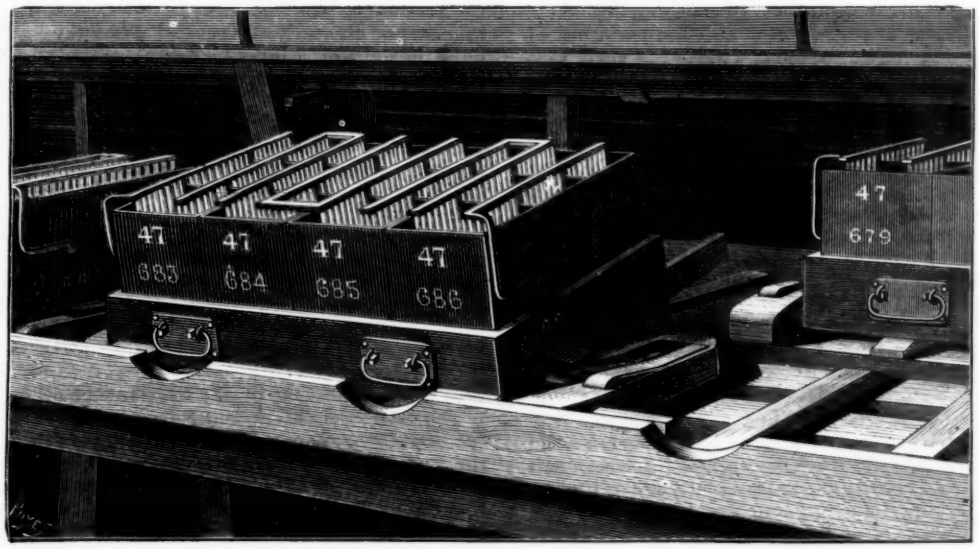


FIG. 2

breaking of the circuit of the machine, thus avoiding all sparks on the commutator.

The motor is a dynamo machine with inductors in circuit capable of supporting a current of 100 ampères at the moment of starting, and working normally with 20 to 30 ampères ; it is placed under the carriage and works the wheels through the medium of an axle. The connection between the motor and this axle is made by means of five ropes of cotton and silk, that between the axle and motive wheels by a Gall chain immersed in an oil bath.

Change of direction is effected by means of a special can be transferred from one end of the car to the other at will. In order to avoid internal short circuits during the working, one of the commutators must be at the notch of rest while the other is at work. This is easily managed by mechanical means which only allow it to be attached to or detached from the axle when it is at the position of rest. Thus all accidents are avoided since only one handle is used in each car.

These are the principal features of the electrical tramways adopted by the city of Brussels, a specimen of which can be seen at work at the Industrial Science and Art Exhibition at the Palais de l'Industrie.

DOMESTIC ELECTRIC LIGHTING.

WENTWORTH CASTLE, near Barnsley, the seat of Thomas C. F. Vernon Wentworth, Esq., has recently been lighted throughout with incandescent lamps by Mr. Wilson Hartnell, of Leeds. The plant consists generally of the engines and boilers, dynamos, and everything complete, and the whole installation maintains over 500 lights, with provision for 600.

As an example of the application of the electric light to a large mansion, we think it would be interesting to give a description of this in detail.

Commencing with the machinery, there are a pair of 12 H.P. Cornish boilers of steel, and of the most modern construction, all the holes being drilled, the flues strengthened by Adams's seams throughout, and suitable in every way for a working pressure of 80 lbs. The boilers are fed by an injector and a Blake's donkey pump, and a large tank has been specially provided for the water supply. The chimney is of wrought iron, placed near the trees so as to be as little prominent as possible; it rises without stays from a stone basement, to which it is secured by bolts of some 13 feet in length.

The engines are horizontal, with cylinders 10½ inches diameter and 16 inches stroke, fitted with Hartnell's patent automatic expansion governors. The speed is 140 revolutions per minute, at which they will indicate 35 H.P. each, cutting off at about one third the stroke. The engines drive a steel countershaft running in phosphor bronze bearings, the latter carrying four pairs of fast and loose pulleys, two pairs of which are for the dynamos and two pairs for the engines. The object of this arrangement is that either or both engines can drive either or both dynamos, and either can be stopped or started independently of the other. We may remark that the engines and dynamos are in duplicate, each set being capable of working about 300 lights.

The whole of the machinery is fixed on heavy stone foundations. The dynamos are two 15-unit Crompton compound-wound machines of the slow-speed type. There is a novelty in the winding and the coupling of these machines. The compound winding is such that the E.M.F. with a constant speed rises with the current to allow for the resistance of the main leads, the total rise with the maximum 320 ampères being from 110 to 134 volts, so as to maintain a constant E.M.F. at the Castle. This includes an allowance due to the estimated reduction in the speed of the engine with a heavy load. A special method of coupling the dynamos had to be adopted, owing to this variation of the E.M.F. (which shall hereafter be described), so that one dynamo could be stopped whilst the other was at work without affecting the E.M.F.

The dynamo main switchboard consists of a black enamelled slate carrying one of Hartnell's patent compound switches for each dynamo. Each switch has eight contact terminals, six of which make or break contact in stopping or starting the dynamo. The advantages of these compound switches over a large number of independent switches are that by one switch all the shunts or circuits necessary to be made or broken in starting or stopping a dynamo are effected by one movement in the proper manner, and in their right order, no mistake being possible, and no skilled manipulation required.

By a further movement of either of these switches the current of either dynamo can be separately measured. There is also a small switchboard connected with the voltmeter for measuring the E.M.F. of either dynamo, the E.M.F. at the Castle and the E.M.F. of the lamps in the immediate neighbourhood. A branch is taken off the main cable underground for supplying the out-buildings. This branch necessitates making a further readjustment of the E.M.F. at the dynamo to keep it constant in the Castle. This is effected by a variable resistance in the shunt coil of each dynamo, which can be simultaneously adjusted by a small switchboard having 36 terminals to each resistance, so that the same adjustments serve for either or both dynamos; this resistance will be automatically worked by Hartnell's patent electrical governor, which has only to correct small differences of E.M.F. due to several disturbing causes; the adjustment, for the most part, being effected by the compound winding and Hartnell's automatic expansion governor on the engine.

The main cables to the Castle switchboard are composed of 19 strands of No. 10 wire of Callender's most highly insulated cable, and are laid on bitumenised wooden supports in a wooden trough filled in with bitumen, the whole being buried in the ground, the cable from switchboard to switchboard being 295 yards (*i.e.*, 590 yards in all). A pair of small wires are laid with the main cables in order to measure the E.M.F. at the castle, in the dynamo house, and to actuate the electrical governor.

The Castle is a quadrangular building with central court, the east and south faces are each about 160 feet long; the western and northern being shorter. The main leads from the switchboard are as follows:—

East wing	... 1	North grand hall, &c.	...	73	lamps.
„ „	... 2	South „ „ &c.	...	35	„
Ditto upper floors	3	North picture gallery, &c.		53	„
„ „ „	4	South „ „ &c.		54	„
South wing	... 5	South circuit	... ...	63	„
West wing	... 6	West circuit	... ...	49	„
North wing	... 7	North circuit	... ...	73	„
				400	

The distributing switchboard contains seven switches, with provision for eight, on a cast iron base; there is also a negative switchboard of enamelled slate for the purpose of isolating the negative wires or measuring the current on either circuit.

In designing the electric light fittings, great care was taken not only to make them suitable to the architectural or decorative features of the various rooms, but also to make them as light and unobtrusive as possible. Glow lamps only weighing a few ounces look well when simply pendant from their own conducting wires, and this feature has been retained in all the upper rooms, pendant for the most part from light brackets on the wall; in several cases the brackets are floral designs of a light simple character and graceful form and free from superfluities, but of the best workmanship.

The general distribution of the wires are as follows:—The leads go direct from the switchboard to one or more vertical wires in each wing, with branches through the passages and branches again into the various rooms, somewhat resembling what may be called the tree system, there being switches in each passage as well as sundry switches in the rooms which are, with few exceptions, of the Lundberg type. The whole of the wires are laid in grooved woodwork, and no wires laid between the floors or out of sight; where, however, the mains necessarily pass through the floors and walls they are wrapped with asbestos and passed through iron pipes to prevent injury from rats or other causes.

The Vitrite holders and Edison-Swan collar lamps are used throughout. Fusible cut-outs are provided for the branch wires to every lamp with few exceptions; there are also numerous cut-outs to the various main branches. In addition to the cut-outs on the distributing switchboard, the mains are protected by a fusible cut-out on the negative cable in the dynamo-house, and there is also a magnetic cut-out (Cunynghame's patent) on the positive leads from each dynamo to the dynamo switchboard.

Wentworth Castle being full of valuable paintings and other objects of attraction, some further detailed description of the lighting of the principal rooms may not be thrown away.

Commencing with the East wing on the upper floor is the picture gallery extending the whole length of the wing, 176 feet long and 24 feet broad, proportionately high and considered to be one of the largest in Yorkshire. The building being of a classical style, the walls are divided by numerous pillasters supporting the architraves which run round, and there are arches near each end resting on white marble.

This is illuminated entirely with side lamps from brackets of light and special design, in appearance resembling the stalks of flowers rising from a group of leaves and drooping over. Leaves of chased brass are placed at intervals on the stem which terminates in a globular frosted glow lamp specially made for this installation. The effect is heightened by mirrors placed between the pillasters, the lights on either side of these bending gracefully forward so as to be reflected. There are 107 lamps in this room, the appearance of the lights hanging from their graceful stems either singly, double, or in groups like bunches of fruit, is exceedingly pleasing if not unique.

The pictures are well lighted, and the whole is seen to great advantage.

Omitting the remainder of the upper rooms we descend the grand staircase which is lighted by a seven lamp electrolier, and enter the Strafford room which is lighted by eight side lights. The walls of this room are lined with valuable pictures, as indeed are all the rooms on the ground floor of the east and south wing. Next follows the dining room lighted by 12 side lights, and also by a pendant electrolier for dining table, &c., containing three groups of lamps under three dome shades which are capable of sliding backwards and forwards. This makes a most effective and brilliant way of lighting a dining room table.

Following on is the grand hall, decorated in white and gold, lighted by 16 side lights. These are for the most part placed in front of mirrors, and on light descending stems proceeding from lion's heads in keeping with the other decorations. It may be here remarked that the whole of the east wall of this storey is decorated with mirrors which have lights on each side of them.

The lower floors of the eastern wing consist of several libraries and sitting rooms which are lighted with side lights on brackets of varied design.

The upper rooms known as the Swan, Roman, Canopy, and Ark are lined with tapestry, doors included, which is said to be unsurpassed. These are all lighted by side pendants of various colours suspended from brackets above the tapestry.

These rooms being also furnished as sitting rooms there are double jointed brackets on either side of the fireplace, for convenience of reading, as there are also in many other rooms. Referring to the other parts of the house it may be remarked that the whole is well lighted; the kitchen, for example, having six pendant lights. An outside cable is run to the conservatory, which is lighted up for reading, writing, &c., the effect of the light amongst the ferns and flowers, orange trees and foliage being charming.

There are sundry outside lamps for lighting up the approaches. The outside premises consist of steward's house, stables and coach houses, cow houses, farm yard, also the laundry, dairy, &c., with other domestic offices.

To light these a branch cable of Callender's make joins the main cable at about 200 yards from the dynamo station. This leads to a Hartnell's patent central switchboard, which is of slate, which switches off both the positive and negative wires, with fusible cut-outs on the main leads and on the positive and negative of each circuit.

These premises are lighted by simple pendants which call for no special remark, excepting that the work is thoroughly done, no part being left unlighted. There are 97 lights on this circuit. There are, besides, 15 lights in the premises adjacent to the dynamo. The greatest care has been taken not only in the general plan of this arrangement but in all the details, from the boilers to the lamps, to make it as perfect as possible in every respect, everything being of the best quality. In addition to the special arrangement for the simplification of the switches, complete instructions, mounted and framed, are placed near each switchboard, and the utmost pains has been taken to make the whole most simple and intelligible.

The installation has now run for over nine months without a hitch of any kind, and that too without the supervision of any electrician or anybody beyond those already employed on the estate. These facts are of the greatest importance in proving that the electric light can be so arranged as to be perfectly trustworthy, easily and inexpensively managed, and to give no trouble whatever.

Its advantages as compared with the paraffin lamps, candles and lanterns previously used are immense, and with such an example of beauty, brilliance and elegance, it is to be expected that ere long we shall see many of the large and historical mansions similarly lighted, and in this way the owners will secure for themselves the greatest comfort, convenience and pleasure whilst adding to their treasures that which is one of the greatest triumphs of the present century.

We congratulate Mr. Hartnell on his success.

GILBERT'S IMPROVED FOOTSTEP FOR TELEGRAPH AND SIGNAL POSTS.

THE object of this invention (which has been patented by Mr. A. E. Gilbert, Telegraph Superintendent of the Highland Railway Company, and has been largely adopted by the Scotch railway companies) is to provide a light, strong, and inexpensive footstep, or support, to be secured to telegraph poles, signal posts, masts, or the like, to form a means of access to the wires or signals carried by the same.

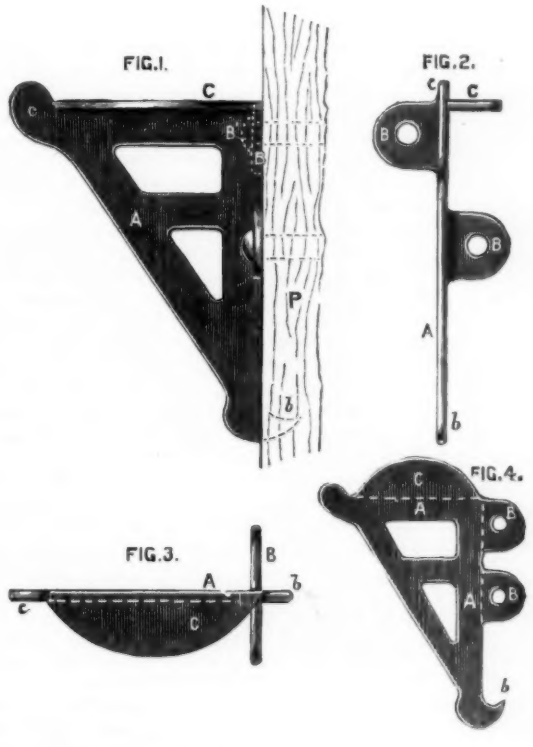


Fig. 1 is a ⅓rd scale side elevation of the improved footstep, A, shown as it would be secured to a wood post or pole, P, for telegraph wires or other purposes; and Figs .2 and 3 are an edge view and plan of the footstep, A, detached, corresponding to Fig. 1; and Fig. 4 is a side view (on a reduced scale) of the blank as cut or punched out of a plate of malleable iron or steel, ready for being put into the compressing dies for bending over the lateral projections, B, B.

Referring to these Figs. 1 to 4, the improved footstep is made by stamping or cutting out of sheet-iron or steel a bracket-shaped piece of approximately triangular form, as particularly shown at A, in Fig. 4, with projecting parts, B, on the vertical edge, which are bent

over on opposite sides to give width to form holding lugs, B, as shown in Figs. 1, 2 and 3. Through holes in these lugs, spikes, wood-screws, or bolts, B^1, are passed, to secure the footstep, A, to the post, P, Fig. 1. A sharp projecting claw, *b*, at the bottom enters the post, and gives additional security to the fixing. A lateral projection, C, at the horizontal top edge forms the tread or foot-plate, C, with a vertical projection, *c*, to prevent the foot from slipping at the outer end of the tread. For lightness the central part of the triangular bracket piece, A, is preferably stamped or cut out as shown.

ELECTRIC LIGHTING IN NEW YORK.

THE New York *Tribune*, in a recent article, calls attention to the wonderful development in that city of "the electric light, which only six years before was an untried fancy in the brain of two or three inventors," and it gives a significant collection of figures on the progress of the business. "It seems like going back a long distance," it says, "to the time when there was nothing but gas lamps all over the city. Yet, in fact, the bulk of the arc lights was put in only between 1883 and 1884. The city had more than 22,000 gas lamps burning in 1879, and the cautious fathers turned a deaf ear to the appeals of all inventors to have the new light tried. In 1880 nearly a thousand new gas lamps were lighted, but after some hesitation the Commissioner of Public Works gave the Brush Company permission to fit out twenty-three arc burners at its own expense, and experiment with them along Broadway. Thirty-two more were mounted the next year, and the success of the experiment seemed assured. The United States Illuminating Company followed the suit of the Brush people in 1882 and put in seventy-three lights, most of them down town. It was in this year that the Union and Madison Square lamps were hoisted into position, and became the two landmarks by night for the heart of the city that the twin lights of the Navesink Highlands are for its outskirts at Sandy Hook."

Coming down to the present time, with 30 miles of streets and 41 acres of park lighted by 708 arc lamps, it remarks: "The Common Council, it seems, has no scruples of that sort, when it comes to the matter of public lighting. That enterprising body has already passed a resolution requesting the Gas Commission to put in through the city, as far north as One Hundred and Twenty-fifth Street, some 2,000 new arc lamps. All the avenues, even B, C and D, are to have electric lights almost from one end to the other, every cross street from Tenth Street to Fifty-ninth Street, Seventy-second, Eighty-sixth, Ninety-second, and One Hundred and Twenty-fifth Streets, Varick, Carmine, Grand, Elizabeth, Mott, Mulberry, and a host of others. The Central Park drives are to blaze with 254 lamps, Bryant Park with 16, and Mount Morris Park with 12. Paradise Park has long been entitled to one electric light, but owing to the squabbles of the Fourth Ward statesmen for the honour of procuring it, the peanut-roasters and hand-organ men have been left in darkness. The Aldermen's resolution is kinder. It gives the park three lamps where but one would have been needed." Anyone who has seen Lincoln Park, in Chicago, lighted up brilliantly by its Thomson-Houston lights will rejoice in the proposed illumination of Central Park, to-day one of the unsafest places in the city after dark. As to the plans of the Edison Company, the *Tribune* says: "The demand has increased, in fact, faster than the supply. The Pearl Street station ran up its capacity to about 12,000 lights, but stuck there, and a sub-station in Liberty Street, with a capacity of 2,000 lamps, had to be opened in the summer just ended. In one way the Company was able to retrench, taking out all lamps that could not be used more than four or five hours a day, and putting in instead the all night or all day ones. Gas has fallen in price several times since the station has been working, but the managers say now that the prospects for extension are greater than ever. The Edison Company, in fact, hopes to have the whole city divided into working districts. A new station will be opened next to the Racquet club-house in West Twenty-sixth Street, with a capacity of 50,000 lamps. Uptown, between Twenty-third and Fifty-ninth Streets, will be cut into halves, and 25,000 lamps will be placed in each. Many of the hotels, theatres, and flat houses have private plants now, and in the more inaccessible regions will have to keep them for several years yet. The Dakota, for instance, has an Edison plant of some 4,000 or 5,000 lamps. But the stations, if the Edison system is perfected, will do away with separate plants, and not only huge flats but single dwelling-houses can be fitted up with incandescents." Of another representative company it says: "The United States Company supplies both arc and incandescent lamps, though its business is rather unequally divided between the two. The city takes 361 arc lamps from it, and it has some 900 other lamps scattered about the city. The arcs in the *Tribune* composing room, which one can see so clearly from the head of Centre Street are this company's. It also lights the American Institute's Exhibition Hall, many ferry houses and down-town shops. In a week or two the plant will be increased to 1,325, all of them of between 2,000 and 2,500 candle-power. The incandescent lamps it furnishes now number about 4,500. No private houses are lighted, only clubs, hotels, shops, and cafés. This branch of electric lighting is not being pushed with much rapidity."

THE BRIGHTON ELECTRIC RAILWAY.

THOSE who are opposed to Mr. Volk's successful electric railway at Brighton have made use of another opportunity of ventilating their hostility, which appears to be as unrelenting as it is ill-founded. Several accidents of a comparatively trifling description have recently occurred on the railway, and, although in some instances the sufferers have probably been guilty of contributory negligence, quite a storm was raised about the matter at last Friday's meeting of the Brighton Town Council. A discussion was originated in the report of the Watch Committee, which embodied a letter received by the committee from Councillor Carpenter, who inquired whether it was true, as reported to him, that on the previous Saturday (September 4th) as some boatmen were employed opposite the Royal Crescent in pulling up a boat by means of a capstan, one of them had his arm broken by the electric car running against him. It was also reported (he added) that on September 1st a horse took fright at the electric car, and turning round suddenly, threw its rider, and overturned a lad on a bicycle, who was trodden under the animal's feet and kicked in the face. If the reports of these accidents were true, he wished to know whether they were not sufficiently serious to justify the committee in recommending the council to remove the railway. In reply to this effusion, the committee forwarded a copy of the report of the Inspector of Hackney Carriages, dealing with the subject matter. The accidents referred to (it was stated) did take place, and the man injured received 35s. compensation. A fisherman who, being blind in one eye and slightly deaf, was knocked down by the car on August 20th, sustaining a bruise on one of his legs, received £5 from Mr. Volk. Councillor Carpenter's letter was subsequently again considered, when the committee arrived at a resolution to the effect that at present they had no intention of recommending the removal of the railway. At the council meeting, by request of Mr. Carpenter, the Town Clerk read a clause in the agreement with Mr. Volk, by which the latter undertook, in the event of his railway becoming a nuisance, or a source of injury, annoyance, or danger, to remove it and reinstate the beach within a week of receiving notice so to do from the Corporation. Mr. Carpenter then proceeded to contend that the railway had developed into a nuisance. Councillor Ballard expressed an opinion that the railway would last longer than Councillor Carpenter occupied a seat in the council. It was undoubtedly a great advantage to the east end of the town, and was, on the whole, exceedingly free from accidents. Casualties sometimes happened in the streets and on railways, but would they consider that a sufficient excuse for stopping carriages, cabs, and trains? Councillor Griffith satirically remarked that at length Councillor Carpenter had made out a case against the railway. A man almost got his arm broken, and he even believed that a boy sustained injury to—his trousers. Councillor Goyne Stevens considered that, in proportion to the large number of passengers it carried, the electric railway enjoyed a far greater immunity from accident than did other modes of locomotion. Councillor Daniel said that it was "extraordinary" that the Council did not recognise that the time had arrived for dispensing with the railway, owing to the inconvenience of having the cars running between the road and the

beach. The adoption of the report having been duly moved, after further discussion, Councillor Carpenter, evidently annoyed by the indifference of the Council to his catalogue of complaints, irately observed that he supposed that after a death had taken place the committee would think of removing the railway, but not before. He moved, as an amendment, the exception of the report from confirmation. Councillor Berry, another uncompromising opponent of the railway, which he described as dangerous to life and limb and detrimental to the inhabitants, seconded the amendment. Councillor Tindal Robertson suggested that the matter should be left over for the consideration of the new Council. He hoped, however, that the committee would eventually find an opportunity for removing the railway into another position. Councillor Styer thought that Mr. Volk's liberality was the cause of the accidents, because in one case a man jumped over the gap near the pier just as the car was approaching: and, in another case, a man was using a capstan bar five feet longer than usual. The amendment was eventually lost and the decision of the committee affirmed.

THE HEATING OF AERIAL CONDUCTORS BY ELECTRIC CURRENTS.*

By J. GILBERT WHITE, PH.D.

(*Continued from page* 189.)

TABLE XXIV.

Changeable Wires. No.	Changeable Wires. Diameter in mils.	Resistance of changeable wire.	Resistance of both.	Resistance of No. 20.	Thompson's Ammeter. Position of movable coils.	Thompson's Ammeter. Reading.	Current in ampères.	Per cent. increase in resistance of changeable wire.	Per cent. increase in resistance of No. 20 wire.	Rise in temperature in degrees C. of changeable wire.	Rise in temperature in degrees C. of No. 20 wire.	Relative rise in temperature of the two wires, No. 20 taken as 100.
20	30·8											
12	78·9	1023	7395	6372	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
12	78·9	1064	10305	9241	8	29·5	17·03	4·01	45·03	10·33	116·1	8·89
16	49·1	2227	7540	5313	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
16	49·1	2412	9131	6719	8	20·7	13·61	8·31	25·57	21·4	65·90	32·47
18	39·8	3254	8605	5351	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
18	39·8	3771	10788	7017	8	21·56	14·18	15 88	31·13	40·93	80·23	51·01
24	19·4	5424	7554	2130	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
24	19·4	6715	8995	2280	32	43·54	7·16	23·80	7·04	61·34	18·14	338·15
28	11·96	6626	7697	1071	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
28	11·96	7857	8950	1093	32	23·34	3·84	18·58	2·05	47·89	5·29	905·3

TABLE XXV.

d = diam. of bare wire in mils.	d = diam. of insulation in mils.	R_I resist. of insul. part wire.	R' = Resists of both parts wire.	Resist. bare part of wire.	Per cent. increase resist. of insul.	Per cent. increase resist. of bare.	Rise in temp. of insul.	Rise in temp. of bare.	Thompson Ammeter.	Current in Ampères.
"UNDERWRITERS'" WIRE. Nos. 16 and 18.										
49·8	116·0	3498	6963	3465	0·0	0·0	0·0	0·0	0·0	0·0
49·8	116·0	3833	7820	3987	9·58	15·07	24·7	38·8	27·37	18·0
39·5	107·0	3885	7490	3605	0·0	0·0	0·0	0·0	0·0	0·0
39·5	107·0	4272	8469	4197	9·96	16·42	25·6	42·3	22·22	14·61
SILK COVERED WIRE, SINGLE "WRAP."										
48·9	51·1	2909	5650	2741	0·0	0·0	0·0	0·0	0·0	0·0
48·9	51·1	4007	8031	4024	37·39	46·76	95·5	120·0	22·66	29·80
CLARK INSULATED WIRE CO.'S WIRE.										
38·2	207·0	3738	7099	3361	0·0	0·0	0·0	0·0	0·0	0·0
38·2	207·0	4171	8446	4275	11·58	27·17	29·4	69·3	13·70	18·02
38·8	235·0	4150	8020	3870	0·0	0·0	0·0	0·0	0·0	0·0
38·8	235·0	4760	10075	5315	14·33	37·34	36·9	96·2	15·90	20·91
49·6	235·0	3920	7512	3592	0·0	0·0	0·0	0·0	0·0	0·0
49·6	235·0	5143	9198	4055	11·27	31·20	28·9	80·0	19·30	25·38
63·5	301·5	3133	6338	3205	0·0	0·0	0·0	0·0	0·0	0·0
63·5	301·5	3669	8272	4603	17·11	43·62	44·33	112·4	31·02	40·79
OFFICE WIRE. Nos. 12, 16, 18 and 20.										
78·9	137·0	3717	7320	3603	0·0	0·0	0·0	0·0	0·0	0·0
78·9	137·0	4119	8317	4198	10·82	16·51	27·9	42·6	27·33	39·54
49·1	106·0	3614	6930	3316	0·0	0·0	0·0	0·0	0·0	0·0
49·1	106·0	4146	8222	4076	14·72	22·92	37·94	59·07	32·95	21·76
39·8	98·0	2657	5238	2581	0·0	0·0	0·0	0·0	0·0	0·0
39·8	98·0	2936	6016	3080	10·42	19·33	26·85	49·82	45·82	15·07
30·8	90·0	2607	5293	2686	0·0	0·0	0·0	0·0	0·0	0·0
30·8	90·0	2820	5903	3083	8·17	14·78	21·06	38·09	30·59	10·06

Throughout the remainder of this article the following symbols are used with the signification attached :—

C = current in ampères.
R = resist. of conductor in ohms.
R′ = resist. of conductor at temp. T, = R (1 + ϕ T).
ϕ = change in resist. of copper for rise of one degree centigrade = ·00388.
T = excess of temp. of conductor over that of room in degrees centigrade.
T_1 = excess of temp. of outside of bare wire or of insulation over temp. of room.
H = rate in calories per second at which heat is developed in conductor = $\frac{C^2 R}{9{\cdot}81 \times {\cdot}424}$.
J = Joule's equivalent = 4·159 watts = 1 calorie.
r_B = radius of bare wire.
r_I = radius of outside of insulation.
d_B and d_I = corresponding diameters.
t = time in seconds.
K = thermal conductivity of insulation.
a = specific electrical resist. of conductor in ohms = $1{\cdot}652 \times 10^{-6}$.
E = absolute emissive power of bare wire or heat given off from one square centimetre of surface, in calories per second, when the wire has an excess of temp. of one degree centigrade over that of surrounding air.
E_I = absolute emissive power of insulation.

Continuing now our theoretical discussion, let us take up first the problem of how the temperature, T, of a bare wire varies with the time after starting a constant current through it. We can readily see that at the first instant the heat developed all goes to warm up the conductor, but as soon as the wire is at all warmed emission of heat begins.

As H represents the heat developed per second, we may represent the rate at which heat is stored in the conductor by S, and the rate at which it is lost or given off by L.

Then for any small time we may write

$$H\,dt = L\,dt + S\,dt. \qquad (1)$$

Now if we let q = quantity of heat necessary to raise the temperature of conductor one degree, then, since T = the excess of temp. of conductor over that of

* New York *Electrician and Electrical Engineer.*

room, $\frac{S\,dt}{q} = d\,T$ = rise in temperature of conductor during dt.

We may, therefore, substitute $q\,d\,T$ for $S\,d\,t$ in the above equation, giving

$$H\,d\,t = L\,d\,t + q\,d\,T \qquad (2)$$

$$q\,d\,T = (H - L)\,d\,t. \qquad (3)$$

$$\text{Now } H = \frac{C^2\,R'}{J} = \frac{C^2\,R}{J}\,(1 + \phi\,T);$$

and by Newton's law, L = surface of conductor × T × E, or $L = 2\,\pi\,r\,l\,T\,E$. Substituting these values in (3) we have

$$q\,d\,T = \left(\frac{C^2\,R}{J}\,(1 + \phi\,T) - (2\,\pi\,r\,l\,E\,T)\right) d\,t \qquad (4)$$

$$d\,t = \frac{q\,d\,T}{\frac{C^2\,R}{J}\,(1 + \phi\,T) - 2\,\pi\,r\,l\,E\,T} \qquad (5)$$

Representing $\frac{C^2\,R}{J}$ by H again, and $2\,\pi\,r\,l\,E$ by E′ we have

$$d\,t = \frac{q\,d\,T}{H + H\,\phi\,T - E'\,T} \qquad (6)$$

$$d\,t = \frac{q\,d\,T}{H - (E' - H\,\phi)\,T} \qquad (7)$$

$$\int_{-o}^{t} dt = \int_{-o}^{-T} \frac{q\,d\,T}{H - (E' - H\,\phi)\,T} \qquad (8)$$

$$t = -\frac{q}{(E' - H\,\phi)} \log_e \frac{H - (E - H\,\phi)\,T}{H} + \frac{q}{E' - H\,\phi} (-\log_e H) \qquad (9)$$

$$t = \frac{-q}{E' - H\,\phi} \log_e \left(\frac{H - (E - H\,\phi)\,T}{H}\right) \qquad (10)$$

$$\log_e \frac{H - (E - H\,\phi)\,T}{H} = -\frac{t\,(E' - H\,\phi)}{q} \qquad (11)$$

$$\frac{H - (E - H\,\phi)\,T}{H} = \varepsilon^{-\frac{t\,(E' - H\,\phi)}{q}} \qquad (12)$$

$$(E - H\,\phi)\,T = H - H\,\varepsilon^{-\frac{t\,(E' - H\,\phi)}{q}} \qquad (13)$$

$$T' = \frac{H}{E' - H\,\phi}\left(1 - \varepsilon^{-\frac{t\,(E' - H\,\phi)}{q}}\right) \qquad (14)$$

Using v and s for the coefficient and exponent respectively of the last form of the equation, we may write

$$T = v\,(1 - \varepsilon^{-st}) \qquad (15)$$

This is the equation of a line passing through the origin and asymptote to a straight line parallel to, and at a distance v above x.

Assuming values for v and s we can plot out a curve by the former equation.

Figure 7, plate I, is thus obtained by assuming a value of 40 for v and $\frac{1}{2}$ for s, and is seen to agree very well in form with the curves determined experimentally.

The derivation of an equation similar to (15) is given later for insulated wire, but the factors are somewhat complicated, hence the derivation is postponed until the effect of an insulating covering has been discussed.

Another problem, and one of more practical importance, is the law for the variation of the permanent temperatures which different currents are able to maintain in the same conductor Here, of course, the heat generated just equals the heat lost by radiation and convection, or

$$H = L \qquad (16)$$

$$\frac{C^2\,R}{J}\,(1 + \phi\,T) = 2\,\pi\,r\,l\,E\,T \qquad (17)$$

$$T = \frac{C^2\,R}{2\,\pi\,r\,l\,E\,J - C^2\,R\,\phi} \qquad (18)$$

For any particular wire under constant conditions of position, circulation of air currents, &c., all the quantities entering into the second term of the last equation except C^2 will be constant. T is therefore a function of C^2, and the curve representing the relations of C and T will be a parabola passing through the origin, and tangent to x at that point.

The only equations which I have been able to find for this relation did not take into account the change of resistance of the conductor for a rise of temperature. This gives a form

$$T = \frac{C^2\,R}{2\,\pi\,r\,l\,E\,J} \qquad (19)$$

in which $T \propto C^2$ or $T : T' : C^2 : C'^2$.

Any T′ obtained from this proportion would be smaller than the true value as obtained by the above equation; for, while equations (18) and (19) have the same numerators, the former has a denominator less than that of the latter by $C^2\,R\,\phi$.

But $C^2\,R\,\phi$ is small as compared with the other part of the denominator; hence when C and C′ are nearly equal we may use the above proportion without appreciable error.

In other words (since $H = C^2\,R$) the heat developed, and consequently the temperature of the conductor, will vary as C^2 if R remains constant; but if R increases with C, then the temperature will increase more rapidly than as C^2.

If the change in R is inappreciable, then the error introduced by considering it constant will also be very small.

How this theory agrees with the results of the experiments is shown by the following table. The figures in the columns headed obs. were taken from the cross-section paper, those in the column headed cal. were calculated from the largest observed T by the formula

$$T' = \frac{T\,C'^2}{C^2}$$

If we take T small and calculate for larger values; then, by the preceding discussion, the observed T′ should be greater than the calculated.

In the table the smaller values were calculated; hence the observed T′ should be smaller than the calculated.

The temperature taken as T in each column is marked by a dash under it.

Currents.		9	9	12	12	15	15	18	18	21	21	24	24	27	27	30	30
Temperatures.	No. of curve on cross-section paper.	Cal.	Obs.	Cal.	Obs.	Cal.	Obs.	Cal.	Obs.	Cal.	Obs.	Cal.	Obs.	Cal.	Obs.	Cal.	Obs.
	1	10·7	9·9	19·0	17·7	29·8	26·5	42·8	38·0	58·3	53·3	76·2	70·0	96·8	96·8	...	...
	2	5·2	5·6	9·2	9·5	14·3	14·8	22·7	21·7	28·0	29·0	36·6	37·0	46·3	46·0	57·2	57·2
	3	4·7	4·6	8·4	8·0	13·1	12·9	18·9	19·2	25·7	26·7	33·6	34·4	42·5	42·5	...	...
	4	4·4	4·7	7·9	8·0	12·3	11·8	17·6	16·1	24·0	22·5	31·4	30·4	39·7	39·7	49·0	49·0
	5	2·9	2·2	5·1	4·2	7·9	6·8	11·5	10·3	15·6	14·6	20·4	19·6	25·7	25·6	31·8	31·8
	6	2·3	1·8	4·2	3·5	6·5	5·6	9·4	8·4	12·7	11·7	16·6	15·9	21·0	21·0	...	...

In plate II. only four of the curves belonging to this set are given. The numbers on each curve indicate the table from which the data for plotting each was obtained. In working up the results, curves corresponding to each table from VIII. to XXIII. inclusive, were drawn. All the others have the same form as those given, and lie between curves XVII. and XXIII. As some of the curves are slightly irregular, it was thought that to try to give them all would tend to confuse, so only four are given.

Another interesting phase of the last problem is to determine whether or not the absolute emissive power is the same for wires of like material but different diameters. By a simple transposition (of 18) we get a value

$$E = \frac{C^2 R (1 + \phi T)}{2 \pi r l J T}. \qquad (20)$$

But instead of R, we may write $\frac{a l}{\pi r^2}$ which substituted (in 20) gives

$$E = \frac{C^2 a (1 + \phi T)}{2 \pi^2 r^3 J T}. \qquad (21)$$

This last expression is equivalent to one derived by Prof. Bottomley of the University of Glasgow, in an article which was published in *La Lumière Electrique*, for October 4th, 1884. He obtains a form,

$$e = \frac{4 C^2 \sigma_t}{J \pi^2 d^2 (t - \theta)}$$

in which σ is equivalent to $a (1 + \phi T)$ and $(t - \theta)$ to T, as used in this article. The two equations expressing the value of E are, therefore, exactly equivalent.

The experiments of Dulong and Petit, and of others, show that it is safe to assume that the power of radiation in different wires of the same material, placed in the same position, will be the same for equal areas, whatever the diameter of the wires.

The same was assumed to be true of convection, by the authors of some of the first articles which were written on this subject, provided, of course, the surrounding conditions remain constant. But experiments have shown, that even under the above conditions, this rule will not hold for convection.

A very good theoretical discussion of the matter has been given by Mr. Perenyi. It was first published in the *Electrotechnische Zeitschrift*, and later in *La Lumière Electrique* for November 15th, 1884. I will translate from the latter paper, changing, at the same time, his symbols into those used in this article.

"If we refer to the formulæ of Dulong and Petit, combined with those of Peclet, we shall find that the heat lost by a conductor in an hour is equal to

$$3600 H = (s' K' + s'' K'') 10^{-3} d l \pi, \qquad (a)$$

an equation in which s' and s'' represent functions of the excess of temperature, and are expressions for the heat lost by radiation and convection; K' is a coefficient of radiation variable with the nature of the conductor, and K'' a coefficient of convection which depends upon the form and the position of the same conductor.

For surfaces horizontal and cylindrical, we have, according to Peclet, per metre square and hour,

$$K'' = 2{\cdot}058 + \frac{76{\cdot}4}{d}.$$

The energy expended per second by an electric current of strength, C, is given by the formula

$$H = \frac{4 a l C^2}{4160 \pi d^2}$$

or the energy expended per hour, calculated for copper, is

$$3600 H = {\cdot}022984 \frac{C^2 l}{d^2} \qquad (b)$$

Putting $(a) = (b)$ we get, substituting at the same time the value of K',

$$7{\cdot}324 \frac{C^2}{d^3} = 0{\cdot}16 s' + s'' K'', \qquad (c)$$

0·16 being the value for copper given by Peclet in a table of values for K'. It is sufficient to compare the results calculated by means of this formula, with those observed by Forbes, to realise the exactness of this last formula.

These results are arranged in the following table :—

Diameter in mm.	Intensity in ampères.		Ratio $\frac{C}{d}$		Calories per hour and per metre of length.		
	Observed.	Calculated.	Observed.	Calculated.	Radiation.	Convection.	Inter. heat.
0·58	9·84	10·337	16·96	17·91	0·1494	8·24	0·000031
1·22	23·04	23·314	18·88	19·11	0·3144	8·38	0·000139
1·58	30·26	30·323	19·15	19·19	0·4071	8·45	0·000234

We see that for copper, K' is very small relative to K'', we may, therefore, with sufficient approximation, neglect in this case the term, K', which gives to equation (*c*) the form

$$7{\cdot}324 \frac{C^2}{d^3} = s'' K''. \qquad (d)$$

If T express the excess of temperature of the conductor, s'' is a function of this excess, and its value is given by the equation, $s'' = n T^b$, in which n and b are co-efficients determined by Dulong, and which have the values, $n = 0{\cdot}3577$ and $b = 1{\cdot}233$. We have, then, finally, by replacing K'' by its value for horizontal cylindrical surfaces in equation *d*,

$$\frac{C^2}{d^3} = \frac{0{\cdot}3577}{7{\cdot}324} \left(2{\cdot}058 + \frac{76{\cdot}4}{d}\right) T^b. \qquad (e)$$

It is to be noted, that for excesses of temperature, comprised between 0·3° and and 3°, T^b is sensibly equivalent to T; so that between these limits we may admit that

$$\frac{C^2}{d^3} = B' T \qquad (f)$$

is sensibly correct, which conforms to Newton's law. But for great excesses, formula (*f*) is quite inexact because of the differences which T and T^b present; thus, for 20° we have $T^b = 40{\cdot}19$. Hence we should, in this case, employ formula (*e*). This formula may be written

$$\left(\frac{C}{d}\right)^2 = \frac{0{\cdot}3577 \times 2{\cdot}058}{7{\cdot}324} d + \frac{76{\cdot}4}{2{\cdot}058} T^b \qquad (g)$$

whence we may derive

$$T^b = \frac{9{\cdot}977}{d + 37{\cdot}12} \left(\frac{C}{d}\right)^2. \qquad (h)$$

According as in this expression we neglect d as compared with 37·12; or 37·12 by the side of d, we arrive at the conclusion that $\frac{C}{d}$ is constant, or (perhaps better) that $\frac{C^2}{d^3}$ is constant; neither of these values, however, being rigorously correct."

I do not think that equation (*g*) of Mr. Perenyi can be applied with any great exactness to the calculations for small wires, owing to varying atmospheric conditions, and to the fact that the experiments for determining K', *b*, *n*, &c., were made with bodies of larger dimensions than the wires under consideration. That the preceding formula is not rigidly correct, is also shown by the following table. In this table the column marked "T^b calculated" is made up of values obtained by the formula (*g*) of Mr. Perenyi, the data for this table being obtained from Table XXIV.

No. of wire.	Diameter in millimetres.	Current in ampères.	T^b calculated.	T^b observed.
12	2·004	17·0	18·4	10·3
16	1·25	13·6	30·9	21·4
18	1·01	14·2	51·4	40·9
20	·78	17·0	124·6	116·1
20	·78	13·6	79·7	65·9
20	·78	14·2	51·4	40·9
20	·78	7·2	22·0	18·2
20	·78	3·8	6·23	5·29
24	·49	7·2	57·2	61·3
28	·30	3·8	43·0	47·9

I do think, however, that Mr. Perenyi has shown conclusively, that the true ratio of current and diameter for constant, T, lies between $\frac{C}{d}$ and $\frac{C^2}{d^3}$, approaching the latter as the diameter increases. And that his results are fairly exact is shown by the table given.

Though we have found a variation of about 50 per cent. in the temperatures for the same wire and current (getting for 26 ampères a temperature of 34, 36·1, 42·8, 79·0, 81·1, and 82·3), still, these largely different values were for extreme conditions, the smallest value being obtained with the wire out in a violent snow-storm, and the largest, with the wire in a closed room heated by steam. An inspection of the results obtained for the wire in a closed room, shows a difference of only a few per cent.; hence, it is not so surprising that the values in the table, page 366, agree so well.

The true ratio of current and diameter, for constant temperature, has been the subject of several solutions, most remarkable in the dissimilarity of the modes of discussion and results obtained.

Mr. Perenyi, whose admirable solution we have given above, in an earlier article, which appeared in *La Lumière Electrique*, for March 22nd, 1884, says (letting H = quantity of heat generated by a current in one second, and T_h the number of degrees it will raise a conductor of given weight and given specific heat), "at the end of n seconds the heat furnished will be n H, and the temperature n T_h. In reality, it will not be thus, because of the heat given up to the surrounding medium. This latter factor is evidently of some importance; but we may, in order to simplify the calculations, suppose that the heat lost per second is inconsiderable." . . . . . "The error concerning the elevation of temperature thus introduced, is analogous to the introduction of a factor of safety into the calculations of strength of materials." But in carrying out the solution on the above hypothesis, Mr. Perenyi entirely neglects the time element introduced above, which is clearly incorrect on his hypothesis. The analogy to the introduction of a factor of safety, is also incorrect; for, as the experiments given in the first part of this article have shown, the factor neglected in the above solution, soon becomes equal to the whole of the heat generated, while the factor retained becomes zero. In computations for lightning rods, the solution would do very well, but for conductors for electric lighting or transmission of power where the current flows for hours, it is clearly incorrect. Thus, by an error in hypothesis and another in solution, a conclusion is reached which is approximately correct; *i.e.*, that for any T, the true ratio of current and diameter is $\frac{C}{d}$. Mr. Perenyi, himself, must have appreciated this, for his later solution given above, is comparatively as good as his earlier one is bad.

A similar result has been obtained, though by different solutions, by several others. Since the difference between this ratio and the true one is on the side of safety, no particular harm could result from its use. Not so, however, with the result obtained by some, that the ratio under consideration is $\frac{C}{d^2}$. The underwriters' rules limit the current to be carried to a certain number of ampères per square inch of cross-section of the conductor, which is equivalent to making the ratio $\frac{C}{d^2}$. The same rule is followed by some of the electricians for some of our principal electric light companies.

Since the true ratio is always between $\frac{C}{d}$ and $\frac{C^2}{d^3}$ we can easily see to what grave results this error might lead in the calculations for large conductors.

Of the earlier solutions, those most nearly correct were given by Prof. G. Forbes and Mr. W. H. Preece. They each determined theoretically, by practically similar solutions, that the ratio of diameter and current for any temperature should be $\frac{C}{d^{\frac{3}{2}}}$ *, the only error in their considerations, being that of assuming the emissive power of the wire proportional to the area; or, in other words, that the absolute emissive power is constant for all wires of the same material under similar conditions.

Prof. Forbes conducted some experiments on the subject, an account of which was given in the *Electrician*, vol. ix., page 497. Each of the three wires was heated to the same temperature (that of melting bee's wax) by increasing the current at intervals by small increments. This temperature having been reached, the current was then determined by the tangent galvanometer. The following table is taken from the article:—

Diameter in mm.	C	$\frac{C}{d}$	$\frac{C}{d^{\frac{3}{2}}}$
0·58	0·984	1·696	2·229
1·22	2·304	1·888	1·709
1·58	3·026	1·915	1·523

An inspection of this table shows that the values of $\frac{C}{d}$ increase as d increases, while the values of $\frac{C}{d^{\frac{3}{2}}}$ decrease as d increases; hence the true ratio must lie between the two. Mr. Forbes, in an article which was published in the *Electrician*, vol. xiii., page 16, says:—"My own view of the matter is, that while, of course, radiation is proportional to the surface, convection is not so, but is nearly constant for rectilinear wires of different diameters but the same temperature, and with thin wires, consequently convection is the most important factor; but for thick wires radiation, proportional to the surface, is the ruling factor."

The theoretical discussion given (page 364), reaches practically this conclusion, and the experiments of Mr. J. T. Bottomley, referred to above, confirm this opinion.

A fairly complete set of experiments on this subject was made by Mr. W. H. Preece, an account of which was given in the *Electrician*, vol. xii., page 518. Mr. Preece in his article seemed to think that his experiments proved the ratio of $\frac{C}{d^{\frac{3}{2}}}$ to be correct; but an inspection of the tables taken from his article shows that his experiments tend to establish the opinion that the absolute emissive power is greater for smaller wires.

(*To be continued.*)

Telegraph Revenue.—The receipts on the telegraph service from April 1st to October 9th, 1886, amounted to £940,000, against £935,000 received from April 1st to October 10th, 1885.

[* This law was, we believe, first arrived at by Mr. H. R. Kempe, having been given by him in the No. of the REVIEW for June 24th, 1882, page 454.—EDS. ELEC. REV.]

REVIEWS.

Heroes of Science. Physicists. By WILLIAM GARNETT, M.A., D.C.L. London: Society for Promoting Christian Knowledge.

From a word on the title-page and a sentence in the preface we should infer that the volume before us is the first of a series in which astronomers, chemists, biologists, &c., will all, in their turns, be duly noticed. Mr. Garnett here limits himself to such physicists as were by birth British subjects and are now no longer living. Hence we have here biographies of Boyle, Franklin, Cavendish, Rumford, Young, Faraday and Clerk-Maxwell, whilst Tyndall, Grove, Joule and other eminent physicists of our own time are excluded. Here, however, we must ask why Gilbert and Brewster are omitted, not to speak of Newton, who is more generally known merely as an astronomer?

The author by no means confines himself to the scientific activity of his heroes and the part they have played in the cause of discovery. Thus the biography of Benjamin Franklin which takes up more than one-fourth of the entire book, deals as largely with Franklin the politician as with Franklin the physicist. Sometimes, indeed, the politician seems to have got the upper hand of the *savant*, as when Franklin concealed his knowledge of the Gulf Stream from political motives.

The author, indeed, draws a contrast between Benjamin Franklin and Henry Cavendish, and seems almost to censure the latter for his exclusive devotion to science. The following passage has certainly a reproachful sound: "Devoting himself to scientific pursuits rather for the sake of the satisfaction which his results afforded to himself than from any hope that they might be useful to mankind, or from any desire to secure a reputation by making them known." In other words, the sole motive of Cavendish was the pure love of truth, alike without reference either to fame or to emolument.

Full justice is here done to the wonderful accuracy of his results. It is shown what anticipations of more recent discoveries have until of late lain buried in the unpublished works of Cavendish. Here, indeed, we cannot hold him entirely blameless. Had he published his researches as made, we cannot doubt but that electrical science would have been more advanced than we now find it. We need say the less concerning this failing in Henry Cavendish, as there is no danger of his finding imitators. Men of science in the present day are sometimes prone to fall into the opposite error, and in their eagerness to "take date," to publish their results without a sufficient verification. It is curious that this excessive reticence was, to some extent, inherited from his father, Lord Charles Cavendish. Franklin, speaking of the latter, is quoted as saying:—"It were to be wished that this noble philosopher would communicate more of his experiments to the world, as he makes many, and with great accuracy."

In the biography of Count Rumford, the founder of the Royal Institution, this establishment, as originally planned, we are told, "appears to embody to a very great extent the work of the Science and Art Department, the City and Guilds Institute for Technical Education, the National School of Cookery, the London Society for the Extension of University Teaching, and in addition to have comprehended a sort of perpetual Health Exhibition." But we do not find that Rumford was aiming at creating a new bureaucracy, or at crushing original thought by a system of examination.

Dr. Thomas Young figures in these pages, correctly enough, as a man aiming at universal knowledge, and in the earlier portion of his life as open to the charge of priggishness. We can scarcely imagine a man of science in our days wasting time in translating passages from Shakspeare into Greek iambics! How varied were his pursuits may appear from his equipment for a tour through the Highlands. He is said to have taken with him "a flute, drawing materials, spirits for preserving insects, boards for drying plants, paper and twine for packing up minerals, and a thermometer." Whilst studying medicine at Göttingen he attended lectures on the History and Constitution of the European States and on the History of Ancient Arts! But this discursiveness, which would have involved most men in shallow dilettantism did not prevent him from doing splendid service in physical science, especially in optics.

It is generally known that Newton had assumed three colours—red, yellow, and blue. Young concluded that the three primaries were red, green, and violet, whilst Clerk Maxwell advocated the claims of red, green, and blue. Camille Kœchlin has recently argued in favour of yellow, blue, and purple (the latter not to be confounded with violet), and Chevreul—certainly no mean authority—still upholds the Newtonian view. Young's greatest achievement is, however, shown to be the demonstration of the undulatory theory of light, as proposed by Hooke and Huyghens in opposition to the emission theory of Newton. The author mentions that for sixteen years, during which he practised as a physician, he was practically lost to science, since a prejudice, not yet extinct, looks askance upon a medical practitioner who shines in scientific research.

Robert Boyle, who has been comically characterised as "the father of chemistry, and brother of the Earl of Corke," may certainly claim to rank as one of the foremost men of science of the seventeenth century, and, indeed, as the pioneer of experimental research in this country. How much he was in advance of his own times, and we might almost add, of common opinion in this nineteenth century of ours, will appear from various remarks here made. Thus, even while at Eton, "he was so addicted to more solid parts of knowledge, that he hated the study of bare words naturally, as something that relished too much of pedantry to consort with his dispositions and designs. Most of our readers will, of course, be aware that he was one of the founders of that 'invisible college,' which was afterwards incorporated by Charles II. as the Royal Society. It is interesting to note that, in Boyle's own words, Our business was (precluding theology and State affairs) to discourse and consider of philosophical inquiries." Thus originated that prudent limitation, which in spite of many attempts at infringment is still, in theory at least, upheld in all our scientific societies. The distinction between the industrial arts and the sciences does not seem to have yet been recognised, since we find in an extract from a letter of Boyle's, navigation placed along with anatomy, geometry, &c.

Boyle's earliest published experiments refer to the properties of the atmosphere as observed by the aid of the air pump. We find him picturing the constitution of the air as consisting "of separate particles each resembling a spiral spring." He noticed that the ticking of a watch ceased to be heard if it was placed within a receiver which was then exhausted. He rejects, on experimental evidence, the "vulgar axiom of the peripateticks that nature abhors and flieth a vacuum," and finally he arrived at the great truth since known as Boyle's law, that the volume of a given mass of a perfect gas varies inversely as the pressure to which it is exposed. The properties of light occupied much of his attention; he detected the phenomenon now known as dichroism, and he effected the actual mixture of light of different colours by means of two prisms.

In the science of heat he established some points of importance. Following up the idea of Bacon, he maintained that heat is a motion of the very small parts of bodies, and that cold is merely a greater or less privation of heat. Magnetism and electricity also shared his attention, though his results in these branches of physics were less important. A painful circumstance which occurred in 1687, or in the earlier part of 1688, has deprived the world of much of his researches:—"Very many of Boyle's manuscripts, which were written in bound books, were taken away and others mutilated by 'corrosive liquors.'" Hence, it is plain that among his associates he had at least one secret enemy of the vilest type.

From Robert Boyle to Michael Faraday seems a mighty stride, the mightier because we so little understand the basis from which the former set out. Faraday was essentially a self-taught man working by methods of his own, and as the author tells us, whilst engaged in the highest branches of experimental reseach he sought successfully to "explain his results by reference to the most elementary mechanical principles only." In consequence his methods "were regarded by mathematicians wtih something more than suspicion" until the gap was bridged over by Sir W. Thomson and Clerk Maxwell. It is difficult to avoid the conclusion, that mathematicians sometimes use physical facts mainly as pegs upon which to hang calculations.

Faraday's early education was very limited, but to such a mind as his this was not utterly disadvantageous. Had he lived at a later date, he might have been stupefied by "preparing for exams." The turning point of his career was his engagement as laboratory assistant in the Royal Institution. His relations with Sir H. Davy were not in all respects such as might have been wished. In 1813, Davy obtained special permission from Napoleon to make a tour in France and Italy, and Faraday accompanied him as his assistant and secretary. But by an unfortunate circumstance the task of valet was thrown upon him. Dr. Garnett does not trouble his readers with the details of all the unpleasantness that occurred, but we read that more than once Faraday was "on the point of leaving his patron and returning home alone," thanks to the airs of Lady Davy. He returned to England in the spring of 1815, and resumed his position at the Royal Institution. Up to 1821 his researches had been chiefly confined to chemistry, and had resulted *inter alia*, in the discovery of benzol. But in that year he entered upon that series of electrical studies which have thrown such a lustre on his name. It is important to remember that, so to speak, Faraday entered the study of physics by the way of chemistry. In that same year he "discovered the rotation of a wire carrying an electric current around the pole of a magnet." In 1823 he studied the liquefaction of gases, and concluded, as has since been finally established by Cailletet and Pictet, that there is no difference in kind between gases and vapours. In 1824 he was elected F.R.S., and in 1825, on Davy's recommendation, he was appointed director of the laboratory of the Royal Institution. It is remarked here that "in the course of ten days' experimental work, in the autumn of 1831, Faraday so completely investigated the phenomena of electro-magnetic induction as to leave little, except practical application, to his successors." It is elsewhere recorded of him that when any investigation was completed he used to say: — "There! that is finished; hand it over to the calculators."

His next step was the proof of the identity of frictional and voltaic electricity, which led him to the law of electro-chemical equivalence. The rotation of a beam of polarised light under the influence of the electric current was another capital step, as establishing a relation between light and electricity, which previous enquirers had vainly sought for. The magnetic condition of all matter and the phenomena of diamagnetism conclude the series of discoveries which we have here so briefly glanced at.

Dr. Garnett says of him, "He had a curious habit of separating his religious belief from his scientific work, though the spirit of his religion pervaded his life." This "curious fact" is of value, as refuting an assertion made by Mr. Matthew Arnold in an anti-scientific "Rede Lecture." Said the lecturer:—"Another great and admirable master of natural knowledge, Faraday, was a Sandemannian. That is to say, he related his knowledge to his instinct for conduct, and his instinct for beauty by the aid of Robert Sandemann." As we have just seen, Faraday did no such thing!

This hero of science died in 1867, honoured at home and still more abroad, and the possessor of 95 decorations and diplomas, conferred by universities, learned societies, and foreign governments.

The last of the illustrious physicists, whose lives and achievements are here recorded, James Clerk Maxwell, achieved great things in a relatively short life, and died so lately as 1879, universally regretted. His peculiar bent of mind became early manifest, since at the age of 15 he contributed a mathematical paper to the "Proceedings of the Royal Society of Edinburgh"; but, like most youths of genius, "he did not profit much by the ordinary teaching of the schools." In his 16th year he entered the University of Edinburgh, and three years later he migrated to Trinity College, Cambridge. Here he made a most favourable impression upon all with whom he came in contact.

One fellow student writes of him: "Every one who knew him at Trinity can re-call some kindness or some act of his which has left an ineffaceable impression of his goodness on the memory." He was said to display always the most curious and out-of-the-way information. His private tutor said of him: "It is impossible for that man to think incorrectly on physical subjects." During his career at Cambridge, he had already elaborated much of the subject-matter of his subsequent electrical and optical memoirs, and had developed the principle of the colour top and colour box. In 1856 he became Professor of Natural Philosophy, at Aberdeen, but though he remained here for four years he found the mental atmosphere of Aberdeen less congenial than that of Cambridge or Edinburgh. In 1860 he accepted the chair of Natural Philosophy at King's College, London. In the next year he gave a lecture at the Royal Institution on "The Theory of the Three Primary Colours." He was now placed on the Electrical Standards Committee of the British Association, and most of their work was done in his laboratory. He concluded his researches on the viscosity of gases, and embodied his results in the Bakerian lecture for 1866. After resigning his chair at King's College, he completed his works on "Electricity and Magnetism," and his incomparable text-book on the "Theory of Heat."

In 1871 he accepted the chair of Experimental Physics, at Cambridge, and devised the arrangements of the new laboratory presented to the University by the Duke of Devonshire. Among his latest tasks was to edit the MS. of Henry Cavendish, placed in his hands by the Duke of Devonshire. The volume was published only a few weeks before his death, which took place in 1879, after a short illness.

Professor Tait, as here quoted, says of him most truly: "There seems to be no longer any possibility of doubt that Maxwell has taken the first grand step towards the discovery of the true nature of electrical phenomena."

If the future volumes of "Heroes of Science" are conceived and executed in the same spirit as the one before us it will merit a splendid success.

Electricity in the Service of Man. A popular and practical treatise on the Application of Electricity in Modern Life. From the German of Dr. Alfred Ritter von Urbanitsky. Edited, with copious additions, by R. WORMELL, D.Sc., M.A., with an introduction by JOHN PERRY, M.E., F.R.S.: Cassell and Company, Limited, London.

It is difficult to see the advantage of this volume over the admirable "Domestic Electricity" of M. E. Hospitalier, published a year or two ago, which appeals to a far greater extent to the popular mind than does the present volume. The German author's plea for his work is that as regards electricity, "public interest has been roused, and there is everywhere a desire for information, and a demand for a guide through this mysterious and far-extended territory. Although there is no want at present of works and periodicals which treat of the science of electricity, it is not everybody's business to go through 50 volumes to pick out from amongst the useful and useless that which is needed, and finally to retain just enough to make up one volume. The task of saving a general reader that trouble I undertake, and have sought to convey a clear insight into the whole science of modern electro-

technics, without requiring on the reader's part any special knowledge beyond that of ordinary education." Such remarks as the foregoing are common in works of the description in question, but we think that they had far better have been omitted. There may be a public demand for explanatory works, but the public do not know what they ask for, and the supposition that it is possible to explain a subject so wide in its ramifications as the applications of electricity in a way that shall satisfy the demand is a most absurd one. All attempts of the kind have hitherto been, and we believe will necessarily continue to be, utter failures. In the present instance we find much matter which we cannot imagine the public would take the slightest interest in; there is also much of modern date which is absent. In certain cases where the editors have ventured to alter the original, we think they have made a complete mistake; it is stated "The author's anxiety to avoid the appearance of a mathematical work, which might make the subject repulsive to many, has led him to avoid all symbolic statements whatever. But frequently the symbolic form is the simplest and most intelligible expression of a notation, and is far more readily comprehended by the general reader than a lengthy expression in words. Hence we have followed up the verbal statement by laws by repeating the statement in the symbolic or equational form." That such symbolic explanations are more intelligible to the *general reader* we utterly deny; the very fact of statements in an equational form being given is sufficient to repel the would-be general reader, although such a repulsion would not be warranted by facts.

In the chapter on galvanic batteries we are given a diagram, with explanations of the *original* form of the Daniell battery. What interest or use to the "general reader" such information is, we are at a loss to say; indeed, we continually find useless and obsolete forms of apparatus given, which adds to the bulk of the volume without adding to its utility. On page 126 we come across one of the most absurd figs. for illustrating the Wheatstone bridge that could well have been devised. Where the English translators have added descriptions of apparatus made and used in this country they have been anything but happy in their efforts. As regards the division dealing with "Telegraphy," we have illustrations of apparatus nearly half a century old, and a drawing of the duplex system, which is unlike anything in actual use. The fig. showing the principle of the Bonelli five-wire telegraph (which is erroneously attributed to Bain) is very misleading, as it appears to indicate that the invention is able to transmit the angular and curved form of letters, which the apparatus cannot possibly do. In the department of electric lighting, we have the Ball machine wrongly classed under the definition of unipolar machines, although the explanation makes it perfectly clear what the machine really is.

The electric-transmission of power is dispatched in two pages and a half, nothing whatever being said about the Deprez experiments, which would be of decided interest to the public, for whom the book is produced. Taking the work altogether, we cannot congratulate the editors on having done any great service by having published it.

Secondary Batteries. — We are glad to learn that Professor Silvanus Thompson is engaged in preparing for the press a book, shortly to be published, on "Secondary Batteries." Users of these apparatus have naturally gained a considerable amount of practical experience in dealing with their vagaries, but the information thus obtained is not available to the general practitioner. We hope that Professor Thompson has been able to gather together a mass of useful practical information for the users of secondary batteries, as this is more requisite than scientific treatises on a matter which has already been ably dealt with by Drs. Gladstone and Tribe, and Professor Oliver Lodge.

NOTES.

The Lighting of the Palais-Royal Theatre, Paris.—At the opening of the Palais-Royal Theatre for the season 1886-7, the new system of lighting was inaugurated. In the offices, the *artistes'* rooms, the body of the theatre, the stage and green room, in the side entrances, everywhere, in short, electricity has replaced gas. The body of the theatre is excellently lighted by 165 10-candle lamps, arranged to great advantage in the midst of the pendants of the old chandelier, and in such a manner that it can always be used for gas at a moment's notice, in case of accident. This is not likely to occur, as the installation has been planned with the greatest care. Everything is duplicated—boiler, steam engine, Edison dynamos, and leads. A battery of 27 Faure accumulators, always charged, also ensures the constant lighting of a certain number of lamps. This battery was, besides, indispensable for rehearsals and morning performances. The lamps are all Edison incandescence lamps. No arc lights are used. There are altogether 430 lamps, 285 of 10 candles and 145 of 20 candles. This installation has been set up under the direction of the Edison Company, with the co-operation of the Electro-Mechanical Company, and it is the most complete theatrical installation now in use in Paris.

Electric Lighting at Liskeard.—The recent experiments which have been conducted with the electric light at Liskeard have proved so thoroughly successful as to create an extremely favourable impression in its favour among the inhabitants. With the view of demonstrating the superiority of the electric light, Messrs. Laing, Wharton and Down illuminated a portion of the town with eight arc lamps, each of 1,200 candle-power, these being used in an area comprising the Parade, Pike Street, Market Street, Fore Street, Bay Tree Hill, and Barras Street. The steadiness and brilliancy of the light elicited much admiration from the numerous crowd of sightseers who thronged these thoroughfares to witness the new departure. With the view of giving electricity a thorough trial, lights have been distributed among various shopkeepers, who will make use of them during the next week or two. Mr. Wharton has delivered a lecture on the subject of electric lighting to a large audience, and the enthusiasm with which the innovation has been greeted points to a desire on the part of the tradesmen and private inhabitants of Liskeard to adopt a more efficient system of illumination than that at present in vogue.

The Lighting of the "Orizaba."—In our reference to the lighting of this steamer, on the 1st inst., the name of the vessel was inadvertently spelt *Orifaba* instead of *Orizaba*; and another error was made by the substitution of the name of Gray for that of Mr. Creagh, the electrician to the Pacific Steam Navigation Company.

Hanley and Electric Lighting.—According to the *Gas World*, the latest "fad" of electricians is to light twenty square miles in the Hanley district with the electric light, and, our contemporary adds, "This absurdity was submitted to the last meeting of the Hanley Town Council by the General Purposes Committee, in whose minutes there was a reference to the subject. The cost of this extensive 'installation' is estimated at £90 per mile."

Electric Lighting by Water Power.—The correspondent of the *Electrical World* at Canon City, Col., writes: "It deserves note that the plant at this point is operated by water-power, obtained by means of a wing dam on the river, just below where the Arkansas makes its exit from the Grand Canon. The Canon Thomson-Houston Company has the contract for lighting the State prison located at this place, and has as well an increasing number of commercial lights in the town of Canon City. The contract for public lighting

has now been running a little over a month. The company has made the Denver and Rio Grande Railroad Company a proposal to light the Grand Canon of the Arkansas, and there is a fair promise of acceptance. This, when accomplished, will give the tourist the grandest view to be obtained under such circumstances on the American Continent. It will many times over repay the road for the outlay, besides insuring safety and pleasure to the traveller. At present the Canon is lighted by wood fires, and requires a corps of track walkers. Mr. Frank P. Blake is the superintendent of our company."

Proposed Electric Lighting at Tavistock.—After the conclusion of their experiments at Liskeard, Messrs. Laing, Wharton and Down intend paying a visit to Tavistock, which will, as a test, be lighted by electricity for a fortnight.

Telephony.—The new work shortly to be issued by Messrs. Whittaker and Co., on the "Telephone and its Practical Applications," will be a welcome addition to the literature of electro-technics. The authors, Messrs. W. H. Preece and Maier, have doubtless found much to say that is both novel and instructive, the former gentleman having exceptional opportunities of making himself thoroughly acquainted with numerous points which are not yet completely understood by the many. The question of "induction or leakage" does not yet appear to have been answered to the satisfaction of all.

Eastern Cables.—"Veritas in Numeris," writing in the *Financial News*, calls attention to the decreased receipts of the Eastern and Eastern Extension Telegraph Company, and advises shareholders to enquire whether due provision has been made for the renewal of the cables, some of which are 16 or 18 years old. The receipts of the Eastern Company have decreased during the three months just concluded at the rate of £61,284 per annum as compared with the receipts of the same period in the previous year, and the receipts of the Eastern Extension Company for the same period have decreased at the rate of £120,824 per annum.

Telephone Working.—In our last week's issue we published a paper which Mr. T. D. Lockwood read before the American National Electrical Association. The author, who is so well known in connection with matters telephonic, dealt with a subject which has not yet assumed any particular importance in this country, although it is of great moment in the States where arc light wires are almost as numerous as are telegraph wires here. Nevertheless, that which Mr. Lockwood had to say on the necessity of protecting telephone exchanges, circuits, and appliances from the destructive effects of intense electric currents, is well worthy the perusal of telephonists in this country.

Electric Light Engineering.—A very clearly written and useful paper was that read by Mr. James A. Pentz before the National Electric Light Association in Detroit last month, "On the transmission of power to the dynamo." This article, which we reproduced last week, shows how much power is lost by the intervention of countershafting between the engine and dynamo, and we commend the writer's remarks to our readers, the subject being one worthy of serious study if electric lighting is to be made commercially successful. Mr. Pentz appears to have a leaning towards the employment of high speed engines for electric lighting operations.

The Great Brush Dynamo.—In the REVIEW for September 10th last, we gave an illustration and brief description of this huge dynamo, but further details will be found in the interesting paper by Professor Thurston which we publish this week. The Cowles furnace, which the Brush machine is intended to operate, has already been fully described in our columns.

Electrical Progress in America.—Practical applications of electricity have always received much more extended support in the States than in England, and it is gratifying to note that the order is still "Advance." The *Electrical World* states that the general revival of business has had its effect in increasing the activity that already prevailed in the electrical field. Perhaps the most striking development within the last month or two is that in electric street railways. About a dozen new roads are now building or under contract for construction. Montgomery, Ala., after a successful test, is to have a complete city system, equipped by the Van Depoele Company, which is also putting in roads at Scranton, Pa., and Port Huron, Mich. At Detroit, a new suburban road is on the point of going into operation, and work is laid out for the road around the pleasure resort at Belle Isle. It is stated that Pittsburgh will have a Daft road, and a Sprague road is to be constructed at Orange, N. J. Los Angeles, Cal., is now being furnished with two Daft roads, and another is seriously talked of for Coney Island. Other roads, to a large number, are in contemplation, and our contemporary says it should not be at all surprised to find a round fifty running or equipping by next summer.

The Etève Petroleum Engine.—On Monday a number of visitors were invited to inspect some samples of the Etève-Hume petroleum engine, at the works of Messrs. Priestman Brothers, at Hull. We have already described this engine in our columns, and expressed our conviction that there is a large field for such motors in connection with electric lighting, and we are not surprised to learn that Messrs. Priestman are making large provision at their workshops for their manufacture. Several improvements have been made in their construction since we first mentioned them, not the least of which is that the reservoir is now constructed within the base of the engine itself, thus rendering it much more compact and portable. Several engines were shown, varying from 2 H.P. to 12 H.P., and one or two were to be seen operating the machinery of the workshops as well as a dynamo for lighting purposes. The smoothness, steadiness, and regularity with which these were working was the subject of remark.

Electric Motors for Printing.—The *Electrical World* states that Mr. P. F. Van Everen, the well-known New York printer and publisher of novelties, has had a half-horse Sprague motor running on the Edison circuit, with the lights, for about two years. The motor was one of the first—if not the first—made by Mr. Sprague, and has been in steady use on a small Gordon press, but has not cost one cent for repairs since it was installed. The brushes have never been renewed. Mr. Van Everen found that electric power was the best for the peculiar conditions involved, and the motor has given him unfailing satisfaction throughout.

Swan's Electric Safety Lamp for Miners.—A meeting of the North of England Institute of Mining and Mechanical Engineers was held last Saturday at Newcastle-on-Tyne, Sir Isaac Lowthian Bell in the chair. Mr. J. W. Swan read a paper upon "A portable electric safety lamp for miners." At a previous meeting of the institute in 1885 Mr. Swan exhibited his electric lamp, which at that time possessed no means of indicating the presence of fire-damp. This fact was commented upon at the time, and Mr. Swan, in reply, said he hoped to be able to combine a fire-damp indicator with the lamp. At Saturday's meeting Mr. Swan announced that he had succeeded in this object and exhibited two lamps with fire-damp indicators attached. These were the lamps which were shown by Mr. Swan at the recent meeting of the British Association, and which we have already described. Mr. Swan added that as far as he could judge from the small experimental use of the lamps he now exhibited, they would neither be very troublesome nor very costly. Five horse-power would keep 1,000 lamps going—that was to say, 500 on the charging circuit and 500 in use in the mine. The

cost of lamp renewals would be the heaviest charge. That, he reckoned, would amount to 2d. per lamp per week. Where the number of lamps was considerable 1d. or 1½d. would cover the cost per lamp for wages for keeping the lamps charged and in order. Another 1d., making 4½d. per week, would cover the charge for interest on the capital outlay for cost of lamps and other plant. Mr. Swan intimated that he also makes the indicator in a form which allows of its being swept along the roof of the mine apart from the lamp when searching for gas.

Electric Light Appliances.—We have received from Mr. Rankin Kennedy a descriptive price list of electric light appliances manufactured by him at the Woodside Works, Glasgow. The list includes descriptions and illustrations of a variety of engines, dynamos, and lamps; but its value would be materially enhanced if it were subjected to careful revision.

Personal.—We learn that both Messrs. Bernard Drake and Gorham are leaving, if they have not already left, the employ of the Electrical Power Storage Company. Their paper "On the treatment of secondary batteries," prepared for and read before the recent meeting of the British Association, must be fresh in the minds of our readers.

Electrical Tramcars.—It is not easy to see wherein the cars of M. Julien, which we illustrate this week, differ from those constructed long before by Mr. Reckenzaun, if we except the method of gearing the electromotor to the car wheels. Further details of a more technical character concerning these Continental cars can be found in the REVIEW for January 22nd and 29th of this year.

Proposed Electric Railway for Littlehampton.—The great success which is being achieved at Brighton by Volk's electric railway has aroused a desire of emulation among the smaller watering places which abound on the Sussex coast. Littlehampton, which is just struggling into repute as a seaside resort, has long felt the necessity for some kind of attraction on its beach, and proposals are now under consideration for the erection of a pier and an electric railway. The latter, which is generally regarded with a good deal of favour, would be run from the railway station to the Esplanade, thus constituting an extremely cheap and convenient conveyance for visitors as well as for the regular residents of the place. The railway, if adopted, would be constructed in the same manner as that at Brighton, and as the gauge would only be 3 feet across, the space taken up in the road could not possibly impede local traffic, which, of course, is not very heavy. The fare would be one penny per mile. The Duke of Norfolk, who is a large owner of property in the neighbourhood, has readily assented to the scheme, but the local authority has yet to pronounce its decision on the matter. Plans will be submitted to it which have been prepared by Mr. Grantham, C.E. If the project is not vetoed, it is hoped that Mr. Volk will undertake the construction and management of the railway.

Blowing up a Wreck by Electricity.—Last week the operation of blowing up the French lugger, *Marie Blanche*, which foundered owing to a leak in Plymouth Sound, on September 17th, whilst on a voyage from Dieppe to Bristol with 100 tons of iron ore, was carried out by the officers of the torpedo ship, *Defiance*, on account of the wreck having become a serious hindrance and danger to navigation. The lugger lay seven fathoms under water, and six charges of gun cotton, varying between 36 lbs. and 30 lbs. each were placed as close under the hull of the vessel as possible, whence electric wires were carried to the *Scourge*, tender to the *Defiance*. During the night the wires connecting the cables became parted, owing to the strength of the current, and a delay of three hours occurred in the destruction of the wreck. The *Scourge* and a number of yachts with visitors on board kept at a safe distance, when Miss Grant, daughter of the Admiral-Superintendent of the Dockyard, touched the trigger of the battery which completed the electrical circuit, and caused the simultaneous explosion of the six charges of gun cotton. A low, rumbling noise alone was audible, and the surface of the water was not disturbed to any great extent, these evidences being, to the initiated, the best proof of the success of the explosion. Very soon masses of wreckage appeared on the surface, and a subsequent examination by divers disclosed the fact that the lugger was almost shattered to pieces.

Glasgow College of Science and Arts.—From a copy of the syllabus of this college we observe that in addition to the ordinary day and evening electricity and electrical engineering lectures, a practical "Testing and Research Class" has been started by Principal Jamieson and his chief assistant, Mr. Livingston, of the Postal Telegraphs, Glasgow, for the purpose of enabling students desirous of going forward to the honours' examination of the Science and Art Department and the City Guilds of London Institute, as well as for those actually engaged in the telegraphic, telephonic, and electric lighting industries, to become intimately acquainted with the handling and arrangements of galvanometers, resistance coils, batteries, &c., and the performing of the more important tests connected with these branches of applied electricity. Several students from this college distinguished themselves at the last May examinations of the City and Guilds of London Institution. Mr. John Macfie, telephone inspector, Paisley, carried off the first place in the honours examination in telegraphy with the £5 and silver medal, and he has also been awarded "The John Pender Gold Medal" with the College Diploma in electrical engineering. The syllabus is full of information to science students generally, and should be studied by all interested in the Science and Art and City Guilds of London examinations. It is obtainable by application to the librarian, by post 3d.

The Incandescent Lamp Patent Case.—We are informed that Mr. Henry F. Joel, who joined the provisional committee formed at the instigation of Messrs. Shippey Brothers, for the purpose of investigating the incandescent lamp patent case, resigned after the first meeting. We announced the names of the committeemen in our issue of August 27th.

An Electric Tram Car.—An electric tram car, destined for New York, has been worked for several days in the streets of Brussels, and has given complete satisfaction to the directors of the State railways, and to the various engineers in whose presence the trial trips have been made. The car, which affords accommodation for 70 passengers, has been constructed by the Julien Electric Company. The system adopted by M. Julien, the manager of the company, which is illustrated in our present issue, received the diploma of honour at the exhibition held in Antwerp last year. The car is worked by accumulators.

A Spanish International Exhibition.—An international exhibition, under the auspices of the Spanish Government, will be held at Barcelona from September, 1887, until April, 1888. The exhibition will include all things connected with agriculture, industry, commerce, navigation, electricity, and education. In order to encourage the display of novelties, the Government will guarantee the protection of Spain to the exhibitors of inventions capable of being patented, and of drawings, models, and trade-marks.

Electricity and the Printing Press.—Mr. Jean A. Wetmore, of New York, is stated to be experimenting with a new electrical device for use in feeding sheets of paper to printing presses. It has been tested and works well. It is intended to take the place of men or boy feeders. It is stated to be quite automatic, and notice of any trouble is signalled by it at once ringing a bell.

The Fire at Telegraph Works.—Messrs. Johnson and Phillips write to us that the fire which broke out upon their premises a fortnight ago did not occur, as stated, in the smiths' shop, but in the instrument department, and that the damage done, instead of being "considerable," was hardly worth mentioning, two or three buckets of water, applied by their own men, being sufficient to extinguish the flames.

The Tangent Galvanometer.—Prof. G. Carey Foster, writing in *Nature*, says :—"Attention has recently been drawn more than once (notably by Sir William Thomson, and by Mr. W. H. Preece and Mr. Kempe) to the advantages offered, in certain cases of the use of the tangent-galvanometer, by placing the instrument so that the plane of the coils makes a greater or less angle with the plane of the magnetic meridian. It may not be amiss, therefore, to point out that, in 1869, M. Bertin showed that the sensitiveness of the tangent-galvanometer for strong currents may be increased and the usable range of deflection doubled by placing the circle in a verticle plane inclined at an angle of 45° to the magnetic meridian ("Annales de Chimie et de Physique," 4th series, vol. xiv., p. 27). When readings are taken with the current traversing the galvanometer, first in one direction and then in the other, as would always be done if accuracy were important, the expression for the strength of current is almost as simple when the coils make an angle with the magnetic meridian as when they are parallel to it. In the former case the strength of current is

$$C = \tfrac{1}{2}k \cos \alpha \, (\tan \theta + \tan \theta'),$$

where α is the (fixed) angle between the plane of the coil and the magnetic meridian, and θ and θ' the deflections of the needle from the plane of the coil due to the current in the two directions. θ is reckoned positive in the direction from the plane of the coil towards the plane of the meridian, and θ' is reckoned in the opposite direction. To determine the angle α we have

$$\tan \alpha = \tfrac{1}{2} (\tan \theta - \tan \theta'),$$

and it is probably most convenient to determine the numerical value of $\cos \alpha$ in the first expression from this by tables. If the current be adjusted so as to make the second deflection $\theta' = 0$, we have simply $\tan \alpha = \frac{1}{2} \tan \theta_1$, if θ_1 be the corresponding deflection with the current reversed."

Compass Errors.—An article in the *Liverpool Journal of Commerce* deals with the interesting subject of compass errors, and after enumerating a number of incidents wherein derangements in the needle have been noticed upon the approach of an umbrella, of volunteers with rifles, of men wearing electric belts, and, finally, of men impregnated with iron tonics and other metallic solutions, concludes as follows :—"There are so many causes to make a compass go wrong, that those who profess to know everything have, it is evident, much to learn. Masters of ships, whose certificates are liable to be cancelled or suspended, should never rely solely on the compass. They are useful and indispensable navigation instruments, but they may be misleading, and require supplementing by the log, the lead, and the look-out."

An Electric Novelty for the Brussels Exhibition.—At the Brussels Exhibition of 1888 it is proposed to erect a singular structure. Passengers will enter a car and be carried up a light bridge spanning right over the Palais de l'Industrie, and will there pass hanging gardens and overlook a wide expanse of country ; they will then be carried under the Palais through a kind of subterranean tunnel and back to their starting point. Electricity is to be the motive power.

Electric Fire Alarms at Dundee.—On Saturday afternoon a fire was discovered to have broken out in the extensive range of jute warehouses attached to the Borobridge works belonging to Messrs. J. and A. D. Grimond. The fire was first observed by a stableman named Pedon. Fortunately for Messrs. Grimond, they have one of the best-arranged electric fire-alarms in Dundee. Pedon ran to a disc opposite the burning warehouse, and breaking the glass set the button free. In an instant the fire bell was heard, the disc in the mechanics' shop, and other departments of the works indicated the number of the burning warehouse, and the electric current threw open the doors of the fire-engine house, and freed the hose carriage from all impediment. A very few seconds elapsed before about two dozen firemen were attaching the hose to the mains within the works, and the steam being up on a powerful engine, four strong jets of water were soon playing on the burning warehouse. Very little difficulty was experienced in confining the fire to the warehouse in which it originated. It is estimated that the loss of material and damage to the building will be between £5,000 and £6,000, which is covered by insurance. But for the excellence of the fire-preventive arrangements, the fire would have had much more serious consequences.

Electricity and Horses.—Prof. Place, of the Cavalry School of Saumur, has recently applied electricity with great success to horses which prove refractory while being shod. It is known that a vicious beast will often give much trouble in the operation of shoeing, and may even have to be bound and made to lie down. M. Place's method renders it at once tractable, and permanently cures its aversion to the forge. The electric shock is given through a bridle of special form, from an induction coil actuated by a dry pile.

Electrical Section of the American Institute.—The 86th meeting of the Electrical Section of the American Institute was held on September 22nd, with Presdent Van der Weyde in the chair. A paper was read by Mr. P. Gannon, on a new "automatic return" signal for telephone circuits. As upon the day following the meeting President Van der Weyde was to celebrate his golden wedding anniversary, the members deemed this a fitting occasion to present him with some testimonial of their esteem. Accordingly, Mr. Frank W. Jones being requested to take the chair, he, in a very happy vein, expressed the warm sentiments which the members bore toward the President, and then presented him with a purse of gold on behalf of the members. Dr. Van der Weyde was taken completely by surprise, and was evidently affected by this exhibition of goodwill on the part of the Society. In returning his thanks for the kindness shown toward him, he dwelt upon the fact that he had devoted his whole life to the furtherance of science, and said that he should continue to work as long as it was in his power. He repeated his conviction that the amalgamation of the Society with the American Institute would prove beneficial, and that its influence would continue to spread.

Telephony in the West of England.—More than a month ago we called attention to the progress telephonic matters are making in the West of England under the energetic *régime* of Mr. H. F. Lewis, of the Western Counties Telephone Company. The good work is still going on, and exchanges are shortly to be opened at Worcester, Great Malvern, Shrewsbury, Hereford, Weston-super-Mare, and Weymouth. Bath and Bristol, 12 miles apart, have been connected ; Bournemouth and Poole, six miles ; Torquay and Paignton, three miles ; and Swansea and Llanelly, 12 miles. The company is now engaged in connecting Bristol and Swansea, with intermediate stations at Newport, Cardiff, Pontypridd, Treherbert, and Briton Ferry, a distance of 106 miles. It is also establishing communication between Swansea, Landore, Morriston, Neath, Briton Ferry, and Port Talbot, a distance of 40 miles ; and is joining Bristol and Gloucester, Pontypridd and Merthyr *viâ* Aberdare, Newport and Pontypool, and Worcester and Great Malvern ; all these extensions, it is expected, will have been effected before the end of the year. The connection of Bristol, Portsmouth, Southampton, Bournemouth, and Weymouth with London is also in contemplation.

Another Transmitter.—According to the *Colonies and India*, "some tests have been made at Dunedin with a new telephone, which appear to show that it is greatly superior to those at present in use. A young man named Rabbige some time ago discovered that a mineral ore, found in the Nelson district, could be used instead of carbon, with greatly improved results. The mineral ore is known as chalco-pyrites, composed of copper, iron, and sulphur. Patents have been taken out in London and the Colonies for the invention, which applies only to the transmitter. The diaphragm, or vibrating plate, as it is called by the patentees, is made of ferrotype iron. Just behind this vibrating plate are two small platinised plates at either end of an India-rubber tube, about half an inch long and somewhat less in diameter. The plate nearest the diaphragm is connected with it by means of a thin wire, and the other plate connects with the line wire. The mineral ore is contained, in granular form, in the India-rubber tube between the platinised plates, the pressure being regulated by an adjusting screw. The experiments were made between Dunedin and Christchurch on a wet day, and with a battery of 10 Daniell cells—much less than required for telegraphing in such weather. Very satisfactory results were obtained. The new invention, it is thought, is likely to effect a revolution in long-distance telephony." We do not see anything very new about this transmitter. The patent of Mr. Hunnings which is now in the possession of the United Telephone Company appears to us to cover the material employed by the "young man named Rabbige."

Incandescent Lamp Patents.—Mr. Arthur Shippey writes respecting the specifications of Messrs. Crossley and Hicks, No. 13,201. of 1885, and of Messrs. Swete and Main, No. 6,167, of 1886, abstracts of which appeared in our issue of October 1st, and both of which relate to improvements in incandescent lamps, that he had previously obtained patents for the same purposes. Messrs. Crossley and Hick's specification, he says, is anticipated by his patent, No. 5,955, of 1883.

Incandescent Lamp Patents.—We have received the following copy of a circular which Messrs. Woodhouse and Rawson have forwarded to the trade, under date of October 9th :—"You are doubtless already familiar, in great measure, with the action brought against our firm by the Edison and Swan Company, the result of the maintenance of whose patents in our opinion will be that no electrical firm will be allowed to manufacture or deal in incandescent lamps except under a royalty which is practically prohibitory, and the indirect result of which will be no less disastrous to the makers of dynamos and to electric light contractors. The existing telephone monopoly affords an indication of the results that would follow. We have already entered an appeal against this decision, which comes on for hearing early in November. In doing this, we have been actuated, not only by our own interest, but also from the feeling that it is extremely detrimental to all firms engaged in the electrical trade that any one firm should obtain a monopoly for so important a matter. It has been urged upon us that the subject is one of such vital importance as to justify the united action of the whole of the trade and those interested in electric lighting, and we feel that the expenses connected with the present appeal should hardly be left to fall entirely upon our own shoulders, the expenses that we have already incurred being very heavy. As the result of our communications with various firms, and of a provisional meeting called yesterday to consider the subject, we have been requested to address you with a view to obtain your co-operation, and we would be glad to know your views on the subject and to hear whether you could attend a general meeting of the trade and those interested in electrical matters, to be held at Cannon Street Hotel, at 3.30, on Thursday, the 14th inst. We wish to point out that before we entered into litigation we endeavoured to come to an arrangement with the Edison & Swan Company, but the terms which they demanded were so onerous as to entirely preclude the possibility of a successful manufacture. But at the present time it is possible that the company may be disposed to view the matter differently, and that if the trade combined to represent to them the public and manufacturing interests affected by their action, they might be willing to concede reasonable terms, founded upon a moderate and practicable royalty, which would put an end to further litigation. We may mention that there are many similar instances of successful combined action, and that a similar course is being pursued by Messrs. Gebrueder Naglo, Spieker and Company, and C. & E. Fein to resist a similar attempt of the Edison Company to establish a monopoly in incandescent lighting in Germany."

The meeting above alluded to was held on Thursday, under the presidency of Sir Leopold McClintock. Several prominent manufacturers and representatives of leading electrical companies were present, and, after Mr. F. L. Rawson had explained the position of affairs, stating that without assistance his firm could not continue the case in the Appeal Courts, it was resolved, promises of support having been given, that a committee to be formed should be empowered to take what steps it might deem necessary to resist a monopoly.

NEW COMPANIES REGISTERED.

St. James's Electric Light Company, Limited.—Capital £50,000 in £5 shares. Objects : To enter into a contract dated 1st September, under which Hall and Partners, Limited, undertake to acquire for the company a site in the parish of St. James's, Westminster, for an electric installation. Signatories (with one share each) : W. Hall, Lancing, Sussex ; F. W. Cultack, 69, Ship Street Brighton ; H. Hunter (engineer) and R. Harrison (engineer), 16, St. Swithin's Lane ; J. R. Kirtley, 70A, Aldermanbury ; R. St. George Moore, C.E., 9 Victoria Chambers, Westminster ; M. R. Ward (electrical engineer), 10A, Great Queen Street, S.W. The number of directors is not to exceed five nor be less than three, qualification £100 in the share capital of the company, remuneration £300 per annum. Registered 7th inst. by Hall and Partners, Limited, 10A, Great Queen Street, Westminster.

F. H. Perry & Co., Limited.—Capital £4,000 in £5 shares. Objects : To acquire and carry on the business of Messrs. Perry and Cox, of Victoria Street, Liverpool, opticians, scientific apparatus manufacturers and electrical engineers. Signatories (with one share each) : *F. Hanson Perry (electrician), Mrs. J. M. Perry, Chatham ; *C. H. Thomson, 15, Birchfield Road ; *J. E. Banks, 23, Balmoral Road ; W. Coppin, 181, Islington ; *F. W. Witter, 18, Water Street ; *W. J. Bland, Fairfield ; all in the city of Liverpool. The maximum number of directors is to be six and the minimum three, qualification 10 shares. Mr. Leon Perry and the signatories denoted by an asterisk are the first directors ; the company in general meeting will appoint the remuneration of the board. Registered 8th inst. by Messrs. Jacques and Company, of 8, Ely Place, as agents for Messrs. Layton and Steel, of Liverpool.

DEFUNCT COMPANY.

Telephone Construction and Maintenance Company Limited.—This company not having complied with the requirements of the law has been dissolved under clause 7 (4) of Companies Act, 1880, by notice in the *London Gazette*, dated 3rd September, 1886. The company was registered on the 11th May, 1878, with a capital of £2,000 in £1 shares to acquire the right and interest of Charles Weightman Harrison in patents

relating to improvements in electric telephony and in telephonic apparatus. No return has been filed by the company, and the only shares recorded as taken up are the seven subscribed for by the signatories to the memorandum and articles of association.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Loeb Chemical Electric Light Company, Limited.—The statutory return of this company made up to the 9th inst., was filed on the 11th inst. The nominal capital is £4,000 in £1 shares; 1,000 shares have been taken up and the full amount has been called and paid thereon. Registered office, 19, Soho Square.

British and Colonial Dermatine Company, Limited.—The statutory return of this company made up to 7th ult., was filed on the 9th ult. The nominal capital is £100,000 in £5 shares. 8,681 shares have been taken up, and upon 4,681 shares the sum of £2 10s. per share has been called, and 4,000 shares are considered as fully paid. The amount received on application and allotment is £10,577 10s.; the sum of £1,125 remaining unpaid. Registered office, 20, Great Winchester Street.

Change of Address.—The Globe Electrical and Engineering Company have removed their offices and showrooms to 7, Carteret Street, Westminster, retaining their former premises for stores only.

The London offices of the Scottish Vulcanite Company have been removed from No. 5, Aldermanbury Postern, to No. 91, Fore Street, E.C.

CITY NOTES.

United Telephone Company of the River Plate, Limited.

THE fourth ordinary general meeting of the United Telephone Company of the River Plate, Limited, was held at the offices of the company, No. 131, Wool Exchange, E.C., on Tuesday, 12th October, Mr. F. W. Jones in the chair.

The Chairman, in reviewing the three and a-half years of the company's actual working, remarked that it was no small satisfaction to be able to say that the capital expenditure during that period, as well as the running expenses, have been met out of earnings, and yet more satisfactory to note that the result of that expenditure has been an increase of paying subscribers from about 300 to over 1,600, and the increase of annual value from £6,400 to over £30,000. The continued progress was never so well assured as at the present time. The growth and development of the River Plate, which has been a great factor in the company's progress in the past, is now, more than at any time, in the full tide of prosperity, and it might reasonably be expected that a continual improvement would be shown in their own business for some time to come. A provisional agreement for amalgamation with the opposition company working in Buenos Ayres (the River Plate Telephone and Electric Light Company) was made in March last, and discussions had since taken place with a view to its being carried out, but up to the present time no definite conclusion had been arrived at. In the meantime, the position of this company in relation to the opposition company had considerably improved. The report and accounts having been adopted, the chairman moved a vote of thanks to the resident director in the River Plate (Mr. Adolph Fels), for the exceedingly able manner in which he has conducted the affairs of the company there. A vote of thanks was also passed to the employés in Buenos Ayres for their energy and devotion to the company's business. The retiring director and auditor were re-elected, and the meeting closed with a vote of thanks to the chairman.

Brazilian Submarine Telegraph Company, Limited.—At the general meeting of this Company, to be held on the 4th prox., the directors will recommend the declaration of a final dividend of 3s. per share, payable on the 5th prox., making with the interim dividends already paid, 6 per cent. for the year ended June 30 last. The sum of £13,000 has been transferred to the reserve fund from the profits of the half-year.

The Maxim-Weston Electric Company, Limited.—It is stated that the shareholders have applied for shares of the new issue much in excess of the amount the directors had decided upon allotting at present.

The Indo-European Telegraph Company, Limited.—The directors have declared an interim dividend for the half-year ended June 30th last, at the rate of 5 per cent. per annum, free of income tax, payable on and after the 1st proximo.

The Globe Telegraph and Trust Company, Limited.—The directors have declared dividends of 3s. per share on the preference, less income tax, and of 6d. per share on the ordinary shares, income tax of which has already been deducted.

TRAFFIC RECEIPTS.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 30th September, are £1,678, as compared with £1,862 in the corresponding period of 1885. The receipts for June, estimated at £5,322, realised £5,333.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending October 8th were £2,904 after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

NEW PATENTS—1886.

12415. "Electro-motors." O. W. F. HILL. Dated September 30.

12420. "Combined thermo-electrical and hydraulic apparatus for automatically operating air and water valves," &c. B. BOOTHROYD. Dated September 30.

12422. "Telephonic apparatus and circuits." P. RABBIDGE. Dated September 30.

12451. "Transmitting rotary motion to or from electric machines." J. H. HOLMES. Dated October 1.

12491. "Electric clocks." V. RECLUS. Dated October 1.

12531. "Appliances for the distribution and transformation of electrical energy." R. DICK, R. KENNEDY. Dated October 2.

12533. "Construction of electric bells." H. J. COATES, E. W. J. MACDONALD. Dated October 2.

12534. "Primary electric batteries." H. WEGMERSCH, R. MCKENZIE. Dated October 2.

12595. "Secondary batteries." E. ANDREOLI. Dated October 4.

12605. "Telegraphic relays." A. M. CLARK. (Communicated by C. Diener.) Dated October 4.

12617. "Automatic telegraphs." H. J. ALLISON. (Communicated by the Writing Telegraph Company.) Dated October 5. (*Complete.*)

12623. "Electric safety lamps for use in mines." M. SETTLE. Dated October 5.

12632. "Transmitting and distributing electro-magnetic energy." J. M. V. KENT. Dated October 5.

12651. "Electric safety lamps." J. W. SWAN. Dated October 5.

12656. "Batteries." A. J. BOULT. (Communicated by H. B. COX.) Dated October 5. (*Complete.*)

12668. "Coupling telegraph wires." W. J. P. and W. P. WALKER. Dated October 5.

12756. "The transformation and distribution of electric energy." R. DICK, R. KENNEDY. Dated October 6.

12770. "Galvanic batteries." W. H. MUNNS. (Communicated by H. O. Merzbach and S. O. Eisele. Dated October 7.

12778. "Dynamo-electric machinery or apparatus." S. F. WALKER. Dated October 7.

12779. "Regulator combined with a portable battery." J. B. MEDLAND. Dated October 7.

12786. "Telephones." W. WHEATLEY, W. P. O'REILLY. Dated October 7.

12818. "Secondary batteries." W. W. BEAUMONT. Dated October 8.

12833. "Automatic apparatus for subjecting the person to the action of electric currents." A. LOISEAU, O. PIERRARD. Dated October 8.

12864. "Dynamo-electric machines." W. H. MUNNS. (Communicated by H. O. Merzbach and S. O. Eisele.) Dated October 9.

12880. "Armatures of dynamo-electrical machinery and electrical motors." R. E. B. CROMPTON. Dated October 9.

12928. "Converting alternate rotary motion into continuous rotary motion applicable to various purposes but particularly to the driving of electric light and other machinery attached to the axles of moving vehicles on railways and tramways." J. RADCLIFFE. Dated October 11.

12979. "Electrical communicating apparatus for use in navigable vessels." W. CHADBURN. Dated October 12.

13018. "Electrical apparatus for starting and recording the distance travelled and the duration of race," R. E. PHILLIPS. Dated October 12.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

11570. "Improvements in and connected with electro-magnets and conductors." P. M. JUSTICE. (Communicated from abroad by H. C. Spalding, of America.) Dated September 29. 1s. 1d. Relates to the preparation of insulated wire and to the apparatus employed in manufacturing it and to wind it into electro-magnets or like devices. The object is to utilise paper for this purpose and to produce a conductor or wire insulated therewith, and capable of being bent or wound without injury. The claims are 17 in number.

11850. "A mode of preventing induction in telegraphy, telephony, and the like, and apparatus therefor." W. L. WISE. (Communicated from abroad by J. Rae, and J. C. Simpson, both of the City of Montreal.) Dated October 5. 8d. Consists in using, in all cases, currents of such small volume as cannot by any possibility supersaturate the conductor, these currents being at the same time of high potential. These working currents may be produced by such apparatus as the secondary coil of an inductorium or induction coil or their equivalent, suitably actuated, the volume of the current being determined by the sectional area of the wire, the potential by the strength of the exciting current used in connection with the primary coil and the duration of the flow by the size of the bar magnet.

12110. "Improvements in and connected with telephones." R. R. H. RIDOUT. Dated October 12. 8d. Relates to a transmitter arranged so that the incidence of impulses properly directed upon it occasions friction between loose contact surfaces included in some part or parts of an electric circuit and from the nature of the contact surfaces employed consequent variations in the resistance of such circuit and the strength of the current flowing therein. The claims are 6 in number.

12230. "Improvements in collectors for electric tramways." M. HOLROYD SMITH. Dated October 14. 1s. 3d. Consists, Firstly—In constructing the collector or parts thereof so that the collector shall be flexible, thereby readily to adapt itself to curves or deviations from a straight line; Secondly—To combine guide clearer and guard contact maker and gatherer; Thirdly—To improve form of ends of collector so as to prevent the hauling rope fouling or becoming entangled thereon; Fourthly—To an improved clip for attaching the hauling rope to the car; Fifthly—To an improved form of terminal for the leading wire, combined with an automatic holding and releasing device; Sixthly—To an improved guard for the contact maker. The claims are 6 in number.

12266. "Improvements in ships' telegraphs, and other telegraphic apparatus." I. TALL. Dated October 14. 8d. Claims—1. The combination of a transmitter in which a cam wheel operates a contact lever and makes and breaks a circuit until it is stopped by a button or key pressed into the path of an arm on the cam wheel; and an indicator or receiver in which an anchor propelment operated by the armature of an electro magnet in the circuit operates an escapement or propelment wheel and moves an index on the axis of this wheel to a signal indication on a dial which corresponds to the button or key pressed in. 2. The improved ships' telegraphs substantially as described and represented by the drawing.

12724. "Improvement in galvanic or primary batteries." J. E. LIARDET. Dated October 23. 6d. The zincs in this battery are placed in a solution of the following composition:—Chromate or bichromate of potash, 1 lb.; sea water, 10 quarts; sulphuric acid, 1½ pints to 1 quart; white sulphate of mercury, ¼ oz.; ether or spirits of camphor, ¼ oz. The zincs need not be amalgamated, and with them carbon plates are employed. Claims:—1. An improved galvanic or primary battery, in which the consumption of the zincs whilst the battery is in action, is greatly lessened if not wholly prevented by the use of a solution or solutions, substantially as described. 2. The use in a battery cell as the exciting liquid or liquids of solutions of which sea or salt water is the basis, and containing also an acid or acids and white sulphate of mercury substantially as described.

CORRESPONDENCE.

A Simple Make and Break.

The few lines you were good enough to devote to my "make-and-break" have given rise to a number of claims of priority, which give the question an entirely new and unexpected interest. In your number of September 10th you publish a letter from Sir Ch. E. Bright, claiming the idea of mercurial contact in a closed tube since the year 1847 for Mr. W. H. Hatcher. I think, with careful research, this idea will be found to be of much more ancient date. A very natural question, however, arises from this. How is it that if the idea be so good a one, that for at least forty years it has never been used, but has fallen into such complete oblivion, that different inventors have believed in all sincerity theirs to be a new and original idea. This would be highly interesting to know, and would doubtless do away with the value of claims.

I notice, however, between my make-and-break and the like arrangements an essential difference. In these the air is extracted; in mine I keep the atmospheric air. Please to remark the result of this improvement. The perfect metallic contacts are known, but they are dear; and the endeavour to replace them by another method resolves itself into an effort to find others as good and cheaper. Now, with reference to those which require the air extracted and to replace the same by an inert gas, and to purify the mercury following the Leclanché method, is by no means economical; therefore, it is that the contacts, which resemble mine, cost probably as much as the metallic contacts: mine cost only a few farthings, and I maintain that the contact leaves nothing to be desired. One of my tubes has supported 100,000 sparks of extra current without a very sensitive galvanometer indicating the least alteration in contact.

The idea of a mercurial contact is, so to say, as old as the world, and it is only in the manner of using it that a new claim can be raised. My idea treats, above all, of the economical solution of the problem, and of its special application to the telephone and to telegraphy; and I abandon willingly the welded tube, its many applications, &c., to all possible claims.

I shall be very grateful to you, sir, if you will kindly publish this letter in your next number, and I regret that in consequence of having, somewhat late, become cognisant of the contents of the number for September 10th, that I have not sent the same earlier.

R. Snyers.

Welding by Electricity.

I can bear testimony to the fact that Mr. J. B. Duncan over eighteen months ago applied electricity for welding purposes. I was much pleased on reading his letter in your issue of last week.

R. Gardner.

Nitrite Works, Gateshead,
October 11*th*, 1886.

A New Scale for Tangent Galvanometers.

In answer to Mr. Eden, I may say that I certainly had the object in view of increasing the sensitiveness of the instrument: that seems to me to be the sole purpose of the modification. What is wanted is not necessarily a long scale, but large differences in deflection for small differences in current in the part of the scale used; or, as it is put in my patent, to give a large reading, and spread the middle of the scale out. This is, no doubt, Sir W. Thomson's object—a man like him is not the least likely to have been confused over it.

Though I am very glad Mr. Evershed wrote and mentioned my name in connection with the skew scale, I had intended to let the matter pass, as I cannot claim credit, as Sir W. Thomson published the scale first. The scale seems to have been practically unknown until Mr. Eden brought it prominently forward, and I think if anyone deserves credit in the matter it is Mr. Eden himself, as he has independently invented the scale, and if it comes into general use it will have been his doing.

In answer to "Subscriber," the instrument is mentioned in a patent of Sir W. Thomson's, taken out about this time three years ago. The drawing shows an instrument with four little controlling magnets, arranged in two lines at right angles; so that it does not look like a skew instrument till one thinks about it.

Jas. Swinburne.

The Marchant Engine.

Will you allow me to say a few words with reference to what appeared in your valuable journal of the 8th inst. ?

1. It is certainly "within the bounds of possibility" to do one horse-power on less than 1½ lbs. of coal per hour; but there is no reason to suppose that a "Marchant" will beat any other engine, if the steam pressures are alike in both cases. I think it would come in a bad second.

2. I did not intend to ignore *the existence* of indicator diagrams which you have alluded to, but, not having seen them, I feel bound to "ignore" them in the sense of *not taking them into account*. I am dying to see the cards taken from the pump which supplies the steam-feed; they are sure to be instructive.

3. Your own description of the brake, illustrated on page 277, makes it quite clear that the end of the lever, L, does *not*, "as a matter of fact," turn about the axle as a centre when the engine is said to be doing 100 horse-power on the brake. Mr. A. Howard has missed the "point" near E—the rolling block which *he* says is lifted by the brake, although *you* say they are not attached to each other!

4. In your leading article, on page 345, you speak of "another new thing" and "a beaten track." Now, I for one love new things, and I dislike beaten tracks; and, owing to these little weaknesses, I should be glad to wager a small amount as to the result of testing the Marchant engine by means of an ordinary friction brake. There would be no upsetting of "the theories and reasonings" of engineers by whom the weak points of this "new thing" have for many years been perfectly well understood.

5. As to Mr. Downie's remarks, I am not in the least surprised to hear that the inventor is troubled with a convenient memory, and I almost wish that I could forget *him* easily. Mr. Marchant and a friend (a Mr. Voss, if I mistake not), saw me in the flesh on the afternoon of Tuesday, July 25th, 1882, at 47, Cannon Street, E.C. Two other persons—whose names I can give if required, and of whose existence Mr. Marchant can have ample proofs—were present during the interview, and the three of us were treated to much solemn fooling about "*a further expression of power which shall be greater than that difference of gravity which originally separated the steam from its water.*" Need I say more.

W. H. Massey.

Edinburgh, *October* 12*th*, 1886.

[Into the question of Mr. Marchant's knowledge or ignorance of the laws of thermo-dynamics we do not care to enter. We were simply allowed to make tests with apparatus placed at our disposal, and in which we did not detect anything wrong. Mr. Massey asserts that the brake gives erroneous results, but he says nothing to support his contention. We have suggested that conclusive trials be made by well known men, and we have named several gentlemen of high standing to the manager of the Marchant syndicate. If our results are shown to be fallacious we shall be perfectly ready to admit our error.—EDS. ELEC. REV.]

Will you kindly permit me to ask a few questions anent the results of a trial published in your paper on September 17th last, for the reason that, until some explanation is given thereon, it will be impossible for any engineer to accept your figures in the light of accomplished and admitted facts.

1. Is not the brake power always less than the indicated or calculated horse-power ?

2. Will the indicated horse-power equal the calculated horse-power ?

3. Is not the diameter of the high pressure cylinders 5·5 inches, with stroke of 12 inches, and cut off at two-thirds; and area of piston = 23·56 square inches ?

4. Will not the power developed in high pressure cylinders be at least half of total engine power ?

Now comes the most important question of all :—

5. Can the calculated horse-power (or volume swept) be made in this case to equal the brake horse-power shown by your tables ?

The mean effective pressure during the trial may be taken at 204 lbs., and the mean number of revolutions at 132 per minute. Working out, we obtain a calculated horse-power amounting to less than 40 for the two high pressure cylinders, and the total engine-power will certainly be under 80 horse-power calculated — probably much under. Therefore (*vide* Euclid), 98 horse-power on brake + friction of engine = less than 80 horse-power ! ! !

Whence this paradox ? The source of error cannot rise from a miscalculation of the steam-power; and Messrs. Fraser and Fraser's letter in your last issue precludes all suggestions of extra steam supply.

The brake, then, must be the culprit, and, owing to its peculiar construction, under some conditions a large margin of error might creep in.

In conclusion, let me put this question to Mr. Marchant: Supposing the brake to be fixed in his usual fashion, ready for starting the engine, but instead of starting let the fly nut, *n'*, in your diagram, that is, the nut farthest from the Salter's balance be gradually tightened up. Will not this procedure show much strain on the balance, not one iota of which could be placed to the credit of the engine itself ?

Twister.

October 11*th*, 1886.

[Mr. Marchant will probably take this matter in hand personally, as the questions here put are more pertinent than any which we have hitherto received anent this engine.—EDS. ELEC. REV.]

The Patent Office and New Patents.

The laxity of our Patent Office is much to be regretted. We are supposed to have an accomplished staff of Examiners, whose duty it is to fully examine into and report upon the validity of patents applied for prior to acceptance of the final fees. The question is, Do these so-called examiners do their duty to the public by allowing patentees to pay their cash to the Government for that which they can grant no protection. Were such applications made either in America or Germany they would be refused by the officials on the ground of prior claims, and part of the money would be returned, if applied for; but in England, unfortunately for the British inventor, our laws are different, although I am of opinion that if an action at law was commenced against the Government, the money so received would have to be refunded, it being received for protective rights which the Government had no power to grant, having already received payment from a prior inventor for the same object, and for which protection has been granted under Her Majesty's seal.

Arthur Shippey.

13, King Street, Cheapside, E.C.

[The above is the concluding portion of a letter, the commencement of which deals with a question for the law courts and is therefore excluded.—EDS. ELEC. REV.]

Secondary Generators.

In your issues of June 9th and 16th, 1883, I describe experiments demonstrating the action of secondary generators, and clearly proved that they cannot be worked successfully in series order on constant current supply. I also stated that they could be successfully worked in parallel arc, when they then become beautifully self-regulating.

I write this in the interests of scientific research and accuracy, as it has been put forth by Mr. Zipernowski himself, at the British Association, and by others elsewhere, that he and M. Deri were the first to discover and apply the working of secondary generators in parallel arc supply. These gentlemen have, no doubt, made improvements in the apparatus employed; but that does not, in my opinion, give them a claim to the system of parallel arc supply to secondary generators.

Rankin Kennedy, *Electrician.*

Glasgow, *October* 9*th*, 1886.